Established 1916 as THE OIL WEEKLY

APRIL, 1955

WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING PRODUCING OPERATIONS AND MANAGEMENT

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Exploration Progress Issue

- How will tomorrow's oil l found?
- What advancements hav been made in geophysics?
- What about air shootin and magnetic recordings?

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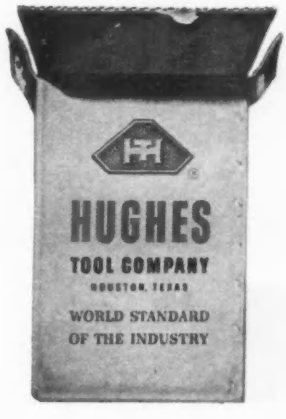

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WORLD OIL

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a quick look at WORLD OIL THIS MONTH

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK ARTICLES

☐ **The three U. S. exploration societies** held their joint annual meeting at month's end in New York City. The general theme: Habitat of Oil in the Sedimentary Basin. For more about the meeting and the new officers of the AAPG, SEG and SEPM, read ... Exploration Societies Meet in New York ... Page 74

☐ **Future petroleum provinces?** It is anticipated that the U. S. will consume twice as much oil 25 years from now as it currently is using. Can that much oil be found? To help answer this question, an eminent geologist takes a look at the possible future petroleum provinces of North America and concludes that much new oil will be found if the incentive to explore is main-

Turn the Page ➧

tained. There are still about as many possible future oil and gas provinces in sight as there ever were in the past, he says. For his summation of the scene today, turn to **Page 76. Where Will Tomorrow's Oil Be Found?**.....**A. I. Levorsen**

☐ **Can industry meet the challenge** of finding enough oil for tomorrow's needs? Will new tools be used? How much oil probably remains unfound? What procedure shows the most promise? For an absorbing discussion of a vital subject, see **Page 82. How Will Tomorrow's Oil Be Found?**..**E. B. Noble and Gilbert M. Wilson**

☐ **U. S. reserves** of liquid hydrocarbons and natural gas increased in 1954 as the amounts proved up exceeded the amounts used. The increases put the reserves at new all-time peaks. Liquid hydrocarbon reserves in Canada similarly were further increased and reached record levels. However, results in the U. S. were the least successful for any postwar year. These findings were revealed in the annual estimates of the American Petroleum Institute and American Gas Association. Estimates for the U. S. are broken down by states. Canada's are shown by province. See **Page 86. U. S. and Canadian Reserves at New Peaks. L. J. Logan**

EXPLORATION ARTICLES

☐ **Geophysical instruments have come a long way** since their early use in oil finding following World War II. They are still electronic devices. But they have been modified greatly and improved. They now provide a much greater range of usefulness in petroleum exploration. Recent improvements represent the first fruit of experimentation and research and point the way to further advances in methods and techniques. See **Page 109. Geophysical Instrumentation Making Rapid Progress** .....**F. J. Agnich**

☐ **The importance of geological surface work** and the need to make use of every available tool in the never-ending search for new oil and gas reserves is emphasized in an article on **Page 112.** A veteran geologist points out that . . . **Geologists are "Working Those Hills"** .....**Frank Gouin**

☐ **Stratigraphic oil accumulations** are becoming increasingly important in the search for new oil. Improvement in exploration methods are necessary to find such accumulations, which are much harder to pinpoint than structures. Beginning on **Page 116** are descriptions of . . . **New Techniques Being Used to Find Stratigraphic Traps** .....
Neal Clayton and Richard A. Pohly

☐ **Magnetic recording of seismic data** affords distinct advantages. But if the full potential of magnetic recording is to be realized, there must be a simultaneous upgrading of all phases of the seismograph operation. In conventional seismograph operations there are often limitations which cannot be overcome by magnetic recording by itself. To make magnetic recorders of maximum usefulness, there must be more careful sizing and placement of shots and the most accurate interpretation possible. Turn to **Page 120** and read . . . **How to Reap Maximum Magnetic Recording Benefits.**.....**Frank B. Coker**

☐ **An improved method** of stratigraphic correlation using the punch-card technique or computing machines especially designed for this purpose is described in the article starting on **Page 132. How Computers Facilitate Stratigraphic Correlations** .....
Charles W. Oliphant and Paul Fullerton

☐ **Details by the dozen** are faced by the geophysical contractor who gets a contract to begin exploratory drilling operations abroad. Turn to **Page 140** for a look at how one such contractor handles the problems. **Geophysical Contracting Abroad a Complex Job. Don Kliewer**

☐ **A new automatic cross-section plotter** makes drastic reduction in time to compute and plot seismic records. This device corrects for the variables which must be introduced in computing results of seismic data taken in the field. As little as one minute is required to compute and plot a single seismogram. A complete cross-section is plotted accurately for final interpretation. For details and examples, read . . . **New Computing Device Aids Seismic Interpretations** .....
Page 142

☐ **The air-shooting method** in seismograph work was found in an extensive independent investigation to be useful and relatively inexpensive as a reconnaissance tool in certain areas. It was found less suitable in other areas. It was found to be particularly advantageous in West Texas and western Canadian areas where there were high velocity sediments and population was sparse. The method was found less satisfactory in soft sediments of the Gulf Coast. Turn to **Page 150. Air Shooting Useful as Reconnaissance Tool** .....
Leon V. Manry and William Sax

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

THIS MONTH . . .

☐ **A new technique** has been added to the tools available in the search for petroleum. It is the study of microfossils found in samples of sediments. Plant spores and pollen are among the microfossils now being used. The microfossils discovered in the samples can be used for age markers, zonation of a formation, and indicators of environment. Deductions based on the environment of deposition may be used to separate the favorable areas from the unfavorable areas for oil exploration. See **Page 156. Microfossils Provide New Technique in Exploration . . . Dr. William S. Hoffmeister.**

DRILLING ARTICLES

☐ **Permian Basin operators and contractors** are proving that mutual investigation of drilling problems pays off. Their combined efforts have led to improved drilling techniques in the area. See **Page 179. Drilling Practices in the Permian Basin . . . R. J. Bromell**

☐ **Damage to pipe** comes from field handling and unloading procedures. But just as damaging is what can happen to expensive strings underground. Beginning on **Page 188** is the conclusion of a three-part series on . . . **How to Run and Handle Drill Pipe . . . . . Richard L. Dailey**

☐ **Save time and expense** of telephone calls from the field. Now the toolpusher doesn't have to call in the drilling report every morning. A new depth chronometer has been devised that is adapted to recording equipment on radio miles away. **New Depth Chronometer . . . . . Page 194**

☐ **A proper understanding** of any tool or piece of equipment helps the operator do a better job. The diamond bit is a tool with certain peculiarities. The article beginning on **Page 198** is designed to familiarize users with the action of the bit so as to achieve utmost efficiency under varying conditions. **How to Get the Most Out of Diamond Bits . . . . . Ed B. Williams, Jr.**

☐ **Sun Oil accepted the risks** when they drilled three relatively large displacement directional wells from Padre Island off the Texas coast out into the Gulf of Mexico. They wanted to test a Marginulina sand structure underlying a portion of the lower Texas Gulf Coast. While the hazards and limitations involved in drilling medium high-angle wells were recognized, the cost of a successful directional campaign as compared with other methods of drilling in the 20- to 40-foot waters made the risks worth taking. For a report on the three wells, turn to **Page 202. Sun Reports on Successful Directional Drilling Jobs . . . . . J. E. Edison**

PRODUCTION ARTICLES

☐ **Well completions can be evaluated** by a new graphic method. Is the completion normal, subnormal, or above normal? Use of a new graphic method will answer these and other questions. Basic data for this new technique, which is a simplification of the Hurst-van Everdingen skin effect phenomenon, are obtained from analysis of bottom-hole pressure buildup curves. Theory, how to use the system, and several examples are presented in the article on **Page 225. How Well Completion Damage Can Be Determined Graphically . . . . . J. J. Arps**

☐ **Got a water-flood problem?** Perhaps your question has been answered by a panel of experts which recently participated in a forum sponsored by the U. S. Bureau of Mines at Bartlesville, Okla. Highlights of the forum are presented in question-and-answer form in . . . **The Experts Discuss Water-flooding . . . . Page 234**

☐ **Flow line paraffin troubles?** Western Kansas operators have devised a simple and inexpensive method for introducing and recovering a plastic or rubber ball covered with chain mesh from the flow line. Photos and details in . . . **Flow Line Rigged for Paraffin Pigs . . . . . Page 240**

☐ **Low treating costs,** good results in combatting sulfate reducing bacteria have been obtained by injecting quaternaries in flood or disposal waters. Formation plugging has been stopped and severe corrosion controlled. This is a new approach to an old and perplexing problem in water injection projects. Turn to **Page 242** for an explanation of what it is, how it works and tests and field applications. **Inhibiting Sulfate Reducing Bacteria Controls Corrosion in Water-flood and Disposal Systems . . . . . C. D. LaSusa**

☐ **Pressure maintenance for fewer wells** or flooding or cycling thin pays heretofore considered unprofitable may be possible by horizontal fracturing. These conclussions were reached after an extensive study of the problem involving conductivity investigations of the direct staggered line-drive patterns. On

Turn the Page ▶

THIS MONTH . . .

Page 246 is the conclusion of a series started in September, 1954. **Water-flooding and Gas Cycling Affected by Horizontal Fractures in Thin Reservoirs**.....**Dr. Paul B. Crawford**

☐ **Corrosion costs can be cut** by using the right inhibitor. How can the degree of corrosion be determined and how can the proper mitigation program be established? Field treatments, case histories before and after proper treatment are presented in the article beginning on **Page 252. Oil Well Corrosion Can Be Licked**.....**S. A. Huckleberry**

☐ **Thermo-setting resins** added to blended Portland cement have improved results in squeeze cementing. This new type cement is capable of penetrating zones of relatively low permeability and has been used to decrease channeling and bypassing, and shut off water coning. See **Page 256.** Characteristics of this cement mixture and how it is used are told in . . . **Thermo-Setting Resins Used in Squeeze Cementing**.... **Anthony Gibbon**

INTERNATIONAL ARTICLES

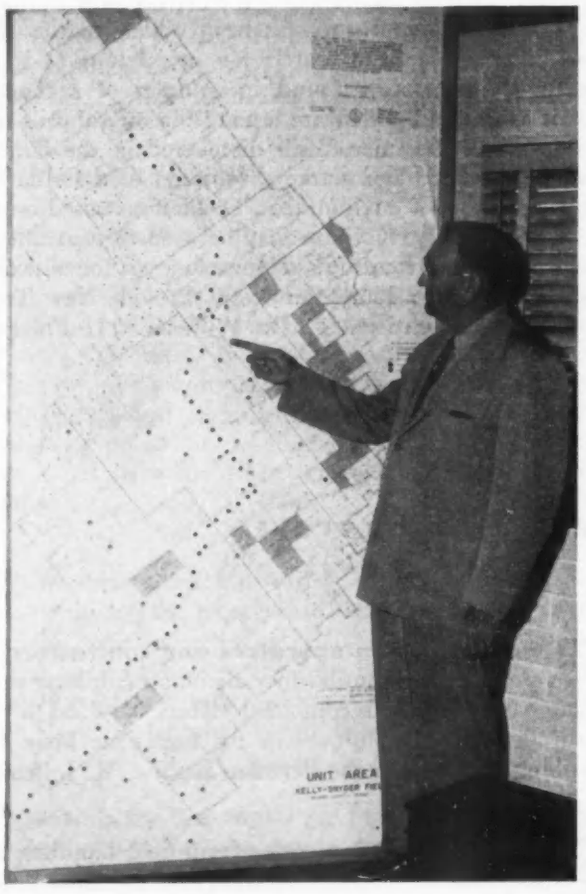
☐ **Discovery of oil in Cuba** has drawn wide attention because the country has established a political atmosphere in which free enterprise thrives. Turn to **Page 277** for the answers by a top government official as to what measures the government has taken and how well its attitude has paid off. A WORLD OIL interview with Ing. Antonio Calvache on . . . **What Cuba Is Doing to Aid Oil Operations**.....**J. E. Kastrop**

☐ **The Netherlands to Maracaibo . . .** Compania Shell de Venezuela has received the first of two new tender-type drilling barges for use in Lake Maracaibo operations. **Barges Built in Netherlands for Use in Lake Maracaibo**.....**Page 278**

☐ **Educational methods** used by Socony-Vacuum Oil Company of Venezuela in training expatriate and national personnel are described in detail in an article beginning on **Page 280.** The author previously wrote on the company's scientific approach to "Manpower Development and Control" (WORLD OIL, August 1, 1954). **Two-Way Training Paves Way for Venezuela Operations**.....**A. R. Taylor**

☐ **Chilean production is up.** So are completions and footage drilled. But in that South American country action is awaited on a modification of petroleum laws which would permit private capital companies to bolster the industry's development further. Turn to Page 290 for the Chilean oil monopoly's 1954 record and proposed changes in the oil law. **Production, Completions and Footage Up in Chile . . . Dr. J. E. Rassmuss**

NEXT MONTH . . .



This is SACROC . . .

Next month, WORLD OIL will bring you the complete story of the country's largest unitization project in the second most important oil field in the U. S. In the photograph above, H. H. Allen, unit manager for SACROC (Scurry Area Canyon Reef Operators Committee) points to the vast 50,000-acre Kelly-Snyder field in West Texas.

The Production Section of WORLD OIL's May issue will be devoted exclusively to this subject. It will include articles on various aspects of this operation, including—

- A guest editorial by Texas Railroad Commission Chairman W. J. (Bill) Murray.
- Organization, background and administration of the unit by Manager Allen.
- Summary report on the reservoir and the unique "center-to-edge" plan of water injection to increase ultimate recovery by 700 million barrels.
- Highlights of production problems and practices.
- And detailed engineering discussions of the surface installations for treating and injecting 200,000 barrels of water daily.

Watch for it in your May issue of WORLD OIL

Looking Ahead . . .

. . . **Most industry engineers will be no more vulnerable** to the draft than before the government dropped oil from its list of essential activities. Chances of individual deferment will vary widely, draft board officials admit, depending (1) upon position with company, and (2) manpower quota of his particular draft board. Non-technical employes will generally be less eligible for deferment henceforth.

. . . **Industry is $540 million behind** in its offshore gamble, estimates Continental's Ira H. Cram. The record: Expenditures, $650 million, revenues, $110 million. Cram told API Southwestern Production Division that lack of governmental cooperation could surely ruin offshore effort. Depletion allowance and expensing of intangible development costs have never been more essential to survival than in offshore operations.

. . . **Floating weather stations in Gulf of Mexico** are proposed in new Congressional legislation. Need for such radar-equipped ships has long been recognized by coastal experts as well as Weather Bureau itself, which has been hampered by limited budget.

. . . **Struggle among technical unions** will follow merger of AFL-CIO. Big union will throw weight behind American Federation of Technical Engineers, 37-year-old AFL organization claiming membership of 7000. Rival group is Engineers and Scientists of America, which has sidestepped affiliation with any trade union.

. . . **Equipment for permanent type well completions** is fast becoming standardized. Services required are being unitized for faster, cheaper operation. There are now more than 2000 installations, perhaps an equal number of modified units.

. . . **Latest development in logging** opens new horizons in well workovers and secondary recovery practices. It is a neutron logger small enough to fit inside two-inch tubing and powerful enough to log formation characteristics.

. . . **A $25 million Saudi Arab-U. S. company** is in the making, say London reports. Saudi Arabian government is reported to have granted International Development Services, U. S. company, a 14-month option for exclusive industrial use of surplus gas in Saudi Arabia for nearly 50 years. Exercise of option would bring about a company financed 30 percent by private Saudi Arab sources, 70 percent by private U. S. capital.

. . . **Use of drill pipe as producing string is distinct possibility.** Tool joint would thus be interchanged on each new well. New pipe would be used to drill, then would act as producing string after being cemented in hole.

. . . **Land operations may benefit** from cost-cutting techniques so necessary to offshore payout. New project illustrating offshore operators' emphasis on economy is Magnolia Petroleum Company's production and gathering facilities being constructed in Eugene Island area, 25 miles off Louisiana. Key considerations are: capacity to handle relatively large volumes; semi-automatic controls to reduce influence of weather; small storage capacity; permanency of installation, and safety factors.

. . . **Machinery replacement needs** in all U. S. industries will approximate $10 billion this year. Machinery needed for expansion will be about $11 billion. This according to the Machinery and Allied Products Institute. Add plant replacement and expansion to this total, and the Institute sees capital outlays of nearly $40 billion by 1965.

. . . **U. S. firms would get better break** under proposed amendment to Turkish oil law. Legislation now under study would cut out much red tape in transfer of profits, increase foreign companies' share of exports, and raise limits on earnings.

46 BOPD FROM WELL THAT SWABBED DRY

DOWELL XM acid treatment achieved this result by control of silicate swelling

Dowell XM acid is designed to control the swelling of silicates and clay minerals which can occur during the acidizing of some limestone and dolomitic formations. It is used to prevent emulsions, and to give easier return of spent acid and faster well clean-up.

This new well, completed in a dolomitic formation, gave only a show of oil on a drill stem test. An ordinary acid treatment was stopped after 27 hours because of excessive pressure with no break. The well swabbed dry. Then the operator called Dowell.

A study indicated that the effective permeability might have been reduced by swollen silicate materials plugging the pore spaces. Dowell engineers recommended the use of XM acid to reduce this swelling.

Following the treatment the well cleaned up readily and swabbed 252 barrels of oil per day, leveling off at 46 BOPD pumping after five months. The operator gave the Dowell XM acid treatment full credit for the oil well—another well saved from abandonment and given productive life. Latest records show that, since this case, the operator has used Dowell silicate control agents in each of his well treatments in that area with similar records of success.

Other Dowell services including fracturing, Electric Pilot and Glass Gun perforating are also used to solve many difficult problems encountered in oil, gas and water wells. For full details contact your nearest Dowell office or write direct to DOWELL INCORPORATED, Tulsa 1, Oklahoma, Dept. D-13.

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Excess Capacity Creates Problems

The petroleum industry of the United States has far more than fulfilled the government established goal of enough capacity to produce, transport and refine 1 million barrels a day in excess of current requirements. Capacity to produce and refine is more than 1½ million barrels greater than current daily needs. This makes the industry capable of meeting a sudden national emergency.

This represents a remarkable accomplishment, in view of greatly increased consuming and producing rates. U. S. daily consumption today is 3 million barrels or two-thirds greater than in 1946. The ability to produce and refine 1½ million barrels more than current rates has been achieved although production has increased by 1¾ million barrels daily and crude runs to refinery stills have risen nearly 2½ million barrels since 1946.

Once again, as it has many times before, the petroleum industry of the U. S. has demonstrated both its ability and willingness to adequately supply all of the nation's oil needs.

•

While desirable as a national defense cushion, surplus producing and refining capacity confronts the industry with serious operating problems. Surplus capacity of this magnitude creates a constant threat of too much crude and refined products. Excessive stocks can be accumulated quickly and easily under such conditions.

The industry, therefore, must learn to live with surplus capacity. Operating levels must be regulated to needs so excessive supply will not wreck the industry's economic position. The situation is not a temporary condition. Surplus capacity is going to be with the industry for many years to come, and the industry will be faced with the necessity of constantly exercising extreme caution for many years to come.

Before World War II, the industry successfully operated with a producing capacity far in excess of its current needs. It can again operate under similar conditions. State conservation agencies provide a means of regulating crude production to needs. It will not always be easy and some producers will experience hardships, but as a whole production can be regulated to proper levels.

•

More difficulty will be experienced in the regulation of refining output to needs. Having invested a great many million dollars in new facilities, owners naturally want to put them in use. No means are available for the regulation of refinery operations—and no one should want any sort of government control.

Therefore, the proper regulation of refining output to current consumption levels must depend upon the voluntary individual action. This thrusts a heavy responsibility upon the refining branch of the industry. Stocks and other market trends must be watched more closely than ever before, and every company must be willing to do its fair share of reducing refinery output or adjusting product yields.

How well the industry succeeds in meeting the situation on a voluntary basis will determine whether all branches of the industry enjoy good conditions or suffer from weakened markets. Excessive output not only will cause price cuts, but result in small refiners demanding protective regulation.

The wise course for the industry will be to try and solve the refining problem on a voluntary individual basis. The burden will fall heavily upon the major companies with large refining capacity.

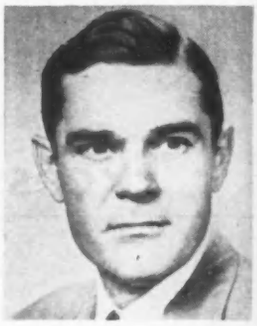
Warren L. Baker

These men will direct the activities

G. M. KNEBEL
AAPG President

HORACE D. THOMAS
AAPG Vice President

ROBERT R. SHROCK
SEPM Vice President



ROY F. BENNETT
SEG Vice President

FRANCIS J. PETTIJOHN
SEPM President

PAUL L. LYONS
SEG President

Exploration Societies Meet in New York City

'Habitat of Oil in the Sedimentary Basin' is theme of four-day convention.

THE EXPLORATION SOCIETIES—American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists—this year moved into New York City for their annual joint convention.

The four-day meeting held at Hotel Statler and ending March 31 had as its theme "Habitat of Oil in the Sedimentary Basin." Papers on the producing basins of the world highlighted the meeting. The Research Committee of the AAPG sponsored a symposium of papers by outstanding authorities on the late Quaternary geology of modern depositional basins.

The SEG and SEPM programs were designed to follow the theme of the meeting.

Elected as presidents of the three societies were: AAPG president—G. M. Knebel of New York City, manager of exploration, Standard Oil Company (New Jersey) and president of Esso Standard (Turkey), Inc., a Middle East affiliate. SEPM president—Francis J. Pettijohn, professor of geology at Johns Hopkins University, Baltimore. SEG President Paul L. Lyons, Anchor Petroleum Company, Tulsa, was elected in the fall of 1953 and took office at the 1954 meeting. New SEG officers will be elected this fall.

Another feature of the March meeting was the AAPG awards dinner. Walter A. Ver Wiebe, professor of geology at the University of Wichita, Wichita, Kansas, and V. E. Monnett, director of the School of Geology at the University of Oklahoma, Norman, were named to honorary memberships in the AAPG. Honorary membership is awarded for distinguished service in the field of petroleum geology. Certificates for these awards and gold membership cards were presented.

The complete list of officers of the three societies is as follows:

AAPG officers. President, G. M. Knebel; vice president, Horace D. Thomas, director, state geologist,

of the AAPG, SEG and SEPM during the coming year

W. A. WALDSCHMIDT
AAPG Secretary-Treasurer

W. C. KRUMBEIN
AAPG Editor

S. P. ELLISON, JR.
SEPM Secretary-Treasurer

A. K. MILLER
SEPM Editor

W. M. FURNISH
SEPM Editor

RALPH E. GRIM
SEPM Acting Editor

HUGH M. THRALLS
SEG Secretary-Treasurer

MILTON B. DOBRIN
SEG Editor

Wyoming Geological Survey, and professor of geology, University of Wyoming, Laramie; secretary-treasurer, W. A. Waldschmidt, consulting geologist, Midland, Texas, and editor of the AAPG monthly *Bulletin* of petroleum geology; W. C. Krumbein, professor of geology, Northwestern University, Evanston, Illinois. The Executive Committee will include above four officers and Edward A. Koester, consulting geologist, Wichita, Kansas, as past president. These men assumed office at close of the New York meeting.

SEPM officers. President, Francis J. Pettijohn; vice president, Robert R. Shrock, professor of geology, Massachusetts Institute of Technology, Cambridge; secretary-treasurer, Samuel P. Ellison, Jr., professor of geology, University of Texas, Austin; editors, A. K. Miller, professor of geology, and W. M. Furnish, associate professor of geology, University of Iowa, Iowa City, co-editors of the *Journal of Paleontology;* and Jack L. Hough and Ralph E. Grim, both of the University of Illinois, Urbana, editor and acting editor, respectively, of the *Journal of Sedimentary Petrology.* The 1955-56 Council will include: Pettijohn, Shrock, Ellison, and Hans Thalmann, Stanford University, Stanford, California, as first past president, and Harold N. Fisk, Humble Oil & Refining Company, Houston, as second past president. These men assumed offices at the close of the New York meeting.

SEG officers were elected in the fall of 1953 and took office at the last annual meeting in 1954. Their successors will be elected in the fall of 1955 and will take office at the 1956 annual meeting. The present officers are, president, Paul L. Lyons; vice president, Roy F. Bennett, Sohio Petroleum Company, Oklahoma City; secretary-treasurer, Hugh M. Thralls, Seismograph Service Corporation, Tulsa, and editor, Milton B. Dobrin, Magnolia Petroleum Company, Dallas.

AAPG President Knebel was born in Waco, Texas, May 15, 1899. After receiving B.A. degree in geology at University of Texas in 1922, he worked for F. C. Dodson, Gulf Production Company, and Freeport Sulphur Company. He joined Humble Oil & Refining Company in 1924 and spent the following six years in East Texas. He then went to Venezuela as chief geologist for Standard Oil Company of Venezuela (Creole Petroleum Corporation). He had risen to company manager when he was transferred to the New York headquarters of Standard Oil Company (New Jersey). In 1944 he became manager of the exploration division of his company and also president of Esso Standard (Turkey), Inc.

Knebel joined the AAPG in 1924. He has twice been a member of the

Continued on Page 81

Where Will Tomorrow's Oil Be Found?

Possible future petroleum provinces are numerous. As many are in sight now as there ever were in past. Large, new provinces may be found in offshore areas, Great Plains region, Rocky Mountain and Mid-Continent basins, and Cambrian rocks.

By A. I. LEVORSEN, Consulting Geologist, Tulsa

IT IS FORECAST that in the U. S. we will be consuming twice as much oil 25 years from now as we do today. We will burn up the equivalent of the East Texas oil pool every year! Do we have it? And where will the oil of the future be found?

The oil in sight today in the U. S. will not begin to meet the needs of 1975-1980, unless we turn to atomic power or to imports as our chief energy source. We have never had in sight more than a relatively few years' supply. We have traditionally depended upon discoveries of new pools to meet our needs. But we are now faced with needs far greater than any we have visualized heretofore.

The word *province* is a loose but useful term that means a group of pools and fields producing under similar geological conditions. The Permian Basin province is an example, and in this province there are sub-provinces, as the Midland Basin sub-province or the Central Platform sub-province. The Salt Dome sub-province of the Gulf Coast province, or the heavy oil province of Wyoming are other examples, and each conveys an idea of the kind of pools and the area. We thus have sub-provinces within provinces, and the geologically related conditions may be either vertical or lateral, or they may be stratigraphic or structural.

A possible province is a "maybe" province. The word *possible* is a very useful term for geologists and is especially apt when referring to the future.

A "future" province is one that is not as yet discovered, or at least whose development is just beginning.

In considering possible future provinces, several factors are involved. They include the following:

1. A province, as an oil or gas pool, is found only by drilling a well. A drilling well is one common denominator of all oil and gas pool discoveries—the only other is that all pools are found in traps. The geologist and geophysicist merely select the best location for the well to test the trap—it is the drill that really decides whether the oil is there. This point leads to a related factor:

2. A favorable economic and political climate is necessary if wells are to be drilled to discover the oil that is under the ground. If, for example, the writer were a barrel of oil, comfortably located in a pool, hidden in a trap deep in the ground, the region that would be the safest for him—where he might live out another 50 or 100 million years in peace and dignity—would be in some country where minerals and exploration are nationalized, such as Russia, Mexico, or Brazil. The reason is that in countries such as these, there is but one hunter, and the chances of eluding him are far better than are the chances of being discovered. The most dangerous place to live, as a barrel of oil, would be along the Gulf Coast, where there are a thousand hunters and each has a different weapon. When we talk of future undiscovered oil and gas provinces, then, it is with the understanding that there will be enough incentive to drill the wells necessary to find them—for without the drill, all the favorable geology in the world will not get us a new province.

The discussion here applies only to the U. S. and Canada, where we are most interested aand where the incentive to discover still exists.

3. Provinces do not come with a calling card and pound on our door to get in. No, they more often slip in unannounced or with very little advance notice. In fact, the lack of enthusiasm that attends so many of the important pool discoveries that open up new provinces is one of the puzzling elements of petroleum exploration.

The Elk City field in the Anadarko basin, for example, was almost passed up—only when the electric log was re-examined in the Houston office of Shell Oil Company was the decision made to set pipe. Almost the same story occurred with Amerada's discovery of the Tioga field in North Dakota that opened up the Williston Basin province. The well went through nearly 1000 feet of Mississippian limestone pay formation without the people on the well realizing it, and when the deep pay was tested, the drill stem test was so poor that the recommendation to pass it up was sent to the Tulsa office. Only when it was noted in the report of the production department that the grass on the lee side of the well showed an oily luster did the men in the Tulsa office order the pipe to be set and the well tested.

Still another example of the discovery of a pool that opened up a new province occurred in 1947. At a meeting of the "high brass" in Imperial Oil Company's office in Toronto, the decision to abandon the well drilling near Edmonton was agreed on. The chief geologist, was instructed to call the Calgary office and shut the well down—the drill was in the D-2 of the Devonian and showed nothing. As he had a golf game on that afternoon—and besides it was the noon hour in Calgary—he postponed phoning the message until the next morning. That was the night the first oil showed in the D-3 zone of Leduc well—and one of the great provinces of the world was opened up.

So many dry structures had been drilled in the region that enthusiasm was low, and if this one had been dry too, the ultimate discovery would have been delayed still longer. Many more such examples could be cited—but these three point up the fact that important discoveries often ride on a slender thread—and the fact that no one likes an area now is no reason that it will not ultimately produce oil.

4. The normal, orthodox, sequence of exploration of a new region is as follows:

Phase I. All structural traps are drilled first. These may be located by surface mapping, by subsurface mapping, or by geophysical surveys. The big advantage of drilling the crest of an anticline is that all reservoir rocks between the surface and the basement are deformed into traps, and one well will test many traps.

Phase II. After the structures have been tested, the stratigraphic data found in these wells are combined with the structural information, and the combination traps, consisting of part structure and part stratigraphic, are drilled. This is more difficult exploration, as generally the objective is only one reservoir rock in each well.

Phase III. Finally, after all the structural and combination traps have been tested, the purely stratigraphic traps are drilled. In those provinces where patchy sands, shoestring sands, deltaic sands, reefs, etc., produce oil with little or no local structure, the slightest evidence is worth drilling. In fact, exploration there often resolves itself into shutting one's eyes and drilling anywhere.

Many of the Rocky Mountain provinces are still in Phase I, West Texas is in Phase II, and the Bend Arch and the East Central Oklahoma areas are largely in Phase III. The different phases often overlap, or some may even be eliminated, as for example, Phase I was quickly exhausted in the Cretaceous province of southwestern Nebraska, and development immediately went into Stages II and III. The point to remember in thinking of the exploration sequences is that new sub-provinces are discovered in each of these phases.

5. The importance of unconformities cannot be overemphasized in thinking of both past and future oil and gas provinces. An unconformity is the boundary surface between two layers or sequences of rocks; nearly every province has several unconformities and some have a dozen or more. The effect of an unconformity is to mask the underlying rocks—a familiar modern example is the surface separating the snow and ice of the Greenland glacier from the underlying rocks. Until one has drilled through the glacier, but little is known of what is below it. The continuing discoveries and long life of many of our provinces is often due to the fact that deeper unconformity surfaces are penetrated by the drill and new rocks and new geological conditions are discovered—most of which were unsuspected. Unconformities help explain, for example, why some of the richest pools of the Permian Basin were found 30 years after the province was discovered.

6. A number of years ago, the writer went to work as a geologist for E. H. Moore, later U. S. Senator Moore. Moore was one of the great wildcatters of Oklahoma. He called the writer in one day and made a remark that bears repeating now. It was this: "Lev, how far do you think I should be *restrained* in my operation by scientific opinion?"

Practically all of our fear about the lack of future provinces comes so frequently now, as it has for as long as the writer can remember, from those who know the most about what has happened in the past—the more knowledge they have, the less future they see. They are, in effect, knowledge bound. Scientists can only predict from what evidence they can see and measure, and current discoveries have always exhausted all of the possible orthodox scientific predictions.

Much of what we predict, when we think of future discoveries, must be based on unknowns or on the most sketchy information. To get more from the scientists, then, we must have more unorthodox information available if they are to continue to make predictions.

Probably no geologist was so unorthodox as to predict East Texas, West Texas, Alberta, or many other provinces. We must admit that scientific geological opinion does at times restrain operations—it is necessary that the geologists continually get new evidence to work with so that they can function most effectively.

When we stop to think about future petroleum provinces, we are really stepping out into an unknown area where the light is very dim. The evidence that can be used is at best fragmentary, and an opinion that some

About the Author

A. I. LEVORSEN, consulting geologist, Tulsa, has served as president of the American Association of Petroleum Geologists, the Geological Society of America, and the American Geological Institute. He is author of the book, *Geology of Petroleum,* published in 1954. Levorsen was born in Fergus Falls, Minn., in 1894. He has received the following degrees: University of Minnesota, Engineer of Mines, 1917; Colorado School of Mines, Doctor of Engineering (Honorary), 1942; and University of Minnesota, Doctor of Science (Honorary), 1947. He was a geologist with various companies until 1935; consulting geologist, 1931-1934; 1935-1945, and 1951 to date; professor of geology and dean, School of Mineral Sciences, Stanford University, California, 1945-1951; and has had foreign geological experience in France, Canada, Brazil, and Pakistan.

Permian Basin Province—West Texas and New Mexico

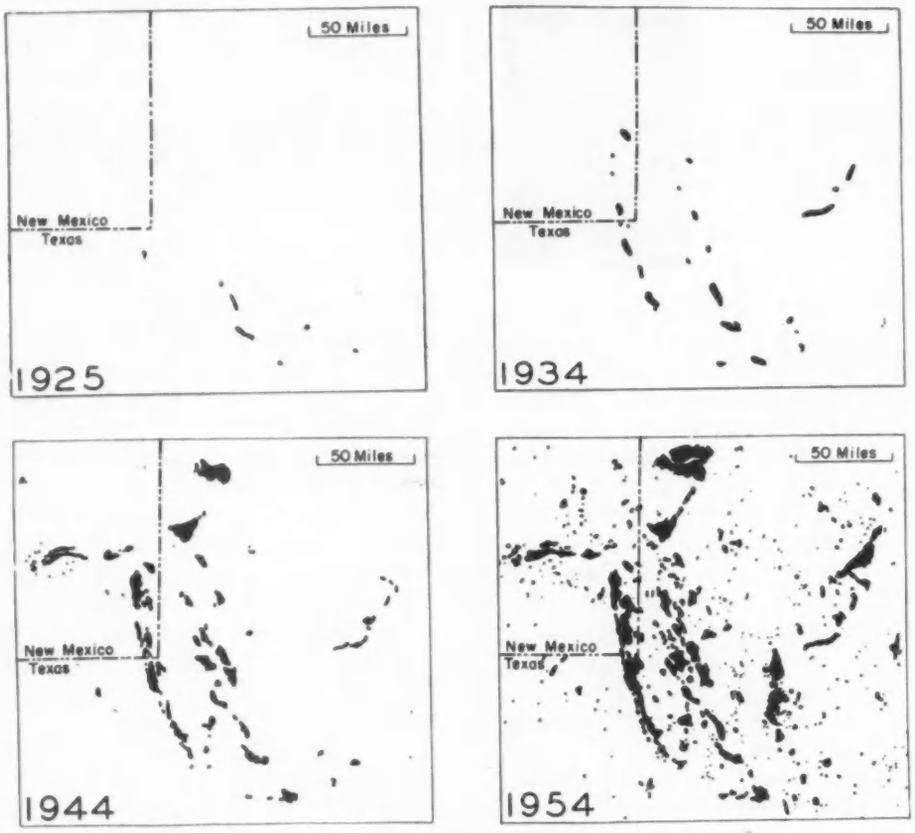


FIGURE 1

barren region will eventually produce oil and gas is generally made when every trap located by orthodox means has been drilled, and every known theory has been tested.

Such an opinion is bound to be unorthodox and can only be made if it is based on some hitherto unknown or unused evidence—in geology this could be an unconformity, a reefing condition, a facies change, or buried folding and faulting. Our experience shows that these things occur frequently—in fact, practically every province contains many such factors that are completely unpredictable.

Is it not reasonable, then, to expect that every large unexplored or partially explored sedimentary region contains unknown factors that may be favorable to oil and gas accumulation? In the last analysis, therefore, we can say that almost every sedimentary section contains a potential oil province until it has been systematically drilled to the basement rocks throughout its extent.

Specific Areas. We now come to suggesting some specific areas that may prove to be petroleum provinces in the future. We are not so concerned with small sub-province as we are with the larger provinces—for it is only by the discovery of many large oil and gas pools that we can hope to supply our needs of the future. Offshore provinces are omitted from this discussion.

1. The Great Plains Region of the U. S. and Canada. The Great Plains region extends from northwestern Canada south to the Rio Grande River—an area some 2500 miles long and from 200 to 600 miles wide. At the south end of the region is the Permian Basin province of Western Texas and New Mexico, shown in Figure 1. The oil fields of the Permian Basin are shown as they existed in 1925, 1934, 1944 and 1954. There was a progressive blackening of the map as discoveries were made and new pools developed. As new unconformities were crossed, new geological conditions were discovered and new waves of discovery followed.

Rocks of all ages from Permian to Camrian were found productive—and richly productive—in this province. No one at any time could know where the next discovery was to be made. The area is in fact an excellent example of the meaning of the word "possible"—for while no one knew where the next pool was located, hope never died. Many knew that more pools were possible, and the search continued.

If we now think of the Great Plains region in terms of what happened in the Permian Basin province, we see the record of the past 22 years in Figure 2. One map shows the oil and gas pools as they were in 1932 and the other the pools as they were in 1954—and the blackening of the map during that time, due to new discoveries, is readily observed.

Are we heading, in this immense Great Plains region, for a repetition of what has happened in West Texas? May we not think of the Permian Basin province as a hand-specimen of the Great Plains? The rocks are the same, the geologic history is comparable, and the kind of oil and gas pools are of a similar pattern. There certainly is no strain on our imagination to see a continued blackening of the map during the next 20 to 30 years throughout this Plains region.

This is a region already of many provinces, but many more sub-provinces may be expected. It is well to remember that the two largest oil pools in the Western Hemisphere—East Texas and Pembina—occur in Upper Cretaceous rocks and are located over 1800 miles apart, and much of the intervening region is underlain by equivalent Cretaceous rocks that are already productive in many places. Who can say that we have found the last Pembina or East Texas Pool? Or the last Cretaceous sub-province?

2. Most geologists have their own ideas as to where the potential provinces are located. A summary of some of the more commonly mentioned possible future petroleum provinces in the U. S. and Canada is shown on the map in Figure 3. They include:

The 30-40,000 feet of Paleozoic sediments of the Arizona-New Mexico-Utah-Nevada region; the thrust-belt areas in California; the Rocky Mountains of Canada and the U. S.; the Ouachita-Marathon region of Oklahoma and Texas, and the Appalachian region.

The Raton Basin and Trinidad Basin, New Mexico and Colorado.

The Sierre Grande arch of New Mexico and Colorado.

The Palo Duro Basin, northwest Texas and New Mexico.

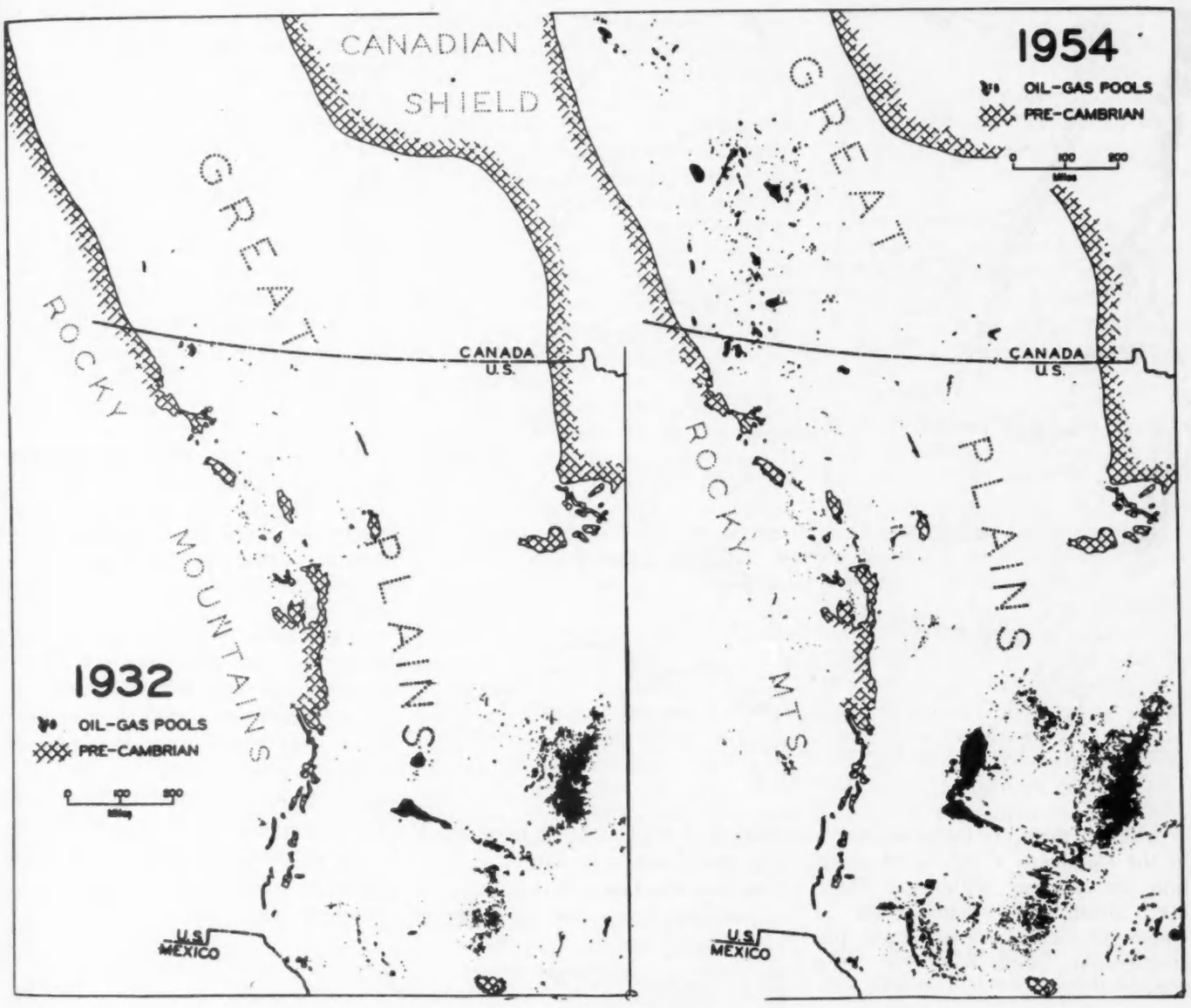


FIGURE 2

The Anadarko Basin, Oklahoma.

The Forest City Basin, Missouri, Kansas and Nebraska.

The Salina Basin, Kansas and Nebraska.

Eastern Nebraska.

Eastern Dakota and Manitoba.

Cretaceous formations of the Great Plains and Rocky Mountains.

The Lower Cretaceous and Jurassic rocks wedging out across the southern end of Appalachian Mountains and into Florida.

3. Cambrian rocks. The present distribution of the Cambrian rocks, both where they crop out and where they are buried, is shown in Figure 4. The places where oil and gas have been found in Cambrian sediments in Wyoming, Kansas, and Texas are shown by circles.

Sediments of Cambrian age have not been considered seriously as reservoir rocks in the past and have seldom been drilled. The reason is that in those places where they have been found to produce oil, there are nearby, younger rocks that are widely productive, and these are generally thought to have supplied the oil found in the Cambrian.

Geologists are not sure that oil was formed in Cambrian rocks, and consequently the Cambrian oil is merely thought to be due to the fact there is a permeable connection that permits leakage from some nearby source. In fact, Cambrian production is generally considered in this respect to be similar to production in Pre-Cambrian and basement granites.

There are so many pools now producing oil from Cambrian rocks, however, that the time has come, it seems, to examine the Cambrian system more closely as a potential, widespread, reservoir rock. As may be seen in Figure 4, Cambrian rocks underlie large areas in the U. S. and Canada. They are chiefly sandstones, dolomites, and shales, and the sands are often extremely permeable. Thicknesses vary greatly and range up to many thousands of feet; wedge-outs of permeability undoubtedly occur.

Except for the lack of provable, indigenous oil and gas, Cambrian sediments seem to represent almost ideal potential reservoir rocks; and it should also be noted that no geologist has yet proved that oil was not formed during Cambrian time and in Cambrian rocks.

All folding that folds the younger rocks also folds the Cambrian, and

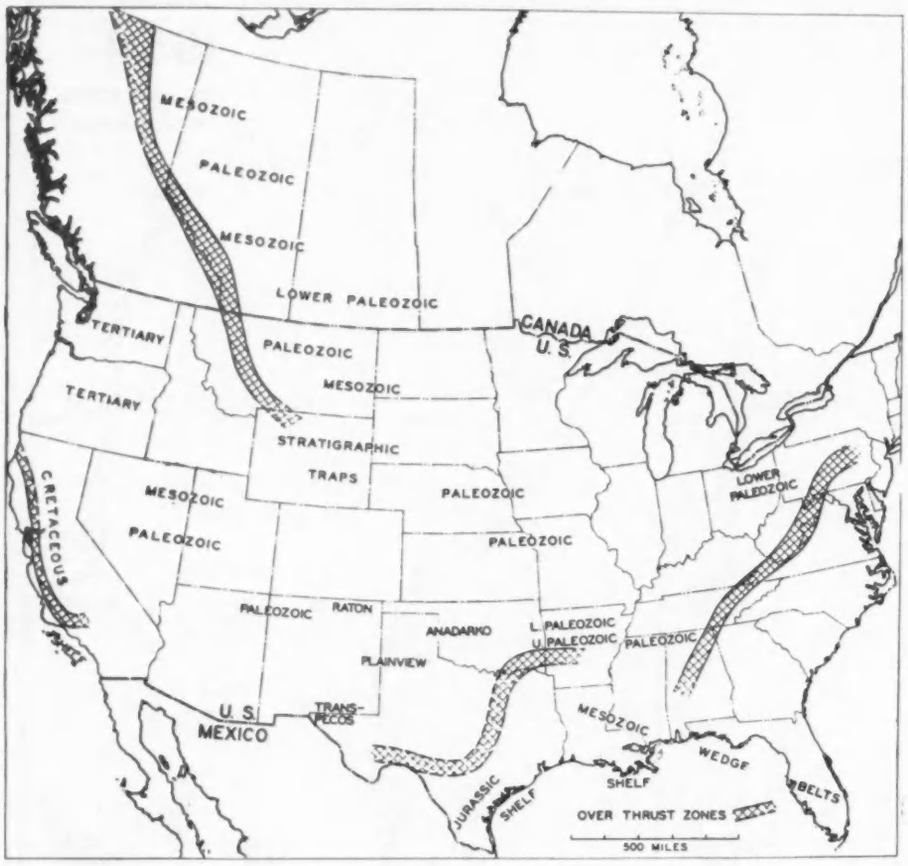


FIGURE 3

in addition there are folds and faults in the Cambrian that do not reach into the younger sediments. There are, consequently, many traps in Cambrian rocks, both structural and stratigraphic, that have not been tested.

If oil can be proved to be indigenous to the Cambrian, then there is no question as to Cambrian rocks, eventually being found widely productive. But, even if oil is not formed in Cambrian rocks, there is enough unknown early Paleozoic folding, faulting and overlapping, that leakage into the Cambrian at some point or at many points, may supply a source of oil. And it could be large. In fact, the large scale of Cambrian deposits, their permeability and the many large untested traps, offers the extremely inviting possibility that the Cambrian will become the next great producing system in the U. S. and Canada.

Certainly, if the writer were in charge of one of the great company organizations exploring all over the world, he would drop down to the lower floor some day and dig out a geologist or two from under the pile of papers where they are now buried, and turn them loose on a regional analysis of the Cambrian possibilities. The payoff could be large!

4. Idea Provinces. There is still another kind of province—it might be called an "idea" province. It consists of associated oil pools that are related to some one principle or idea. Anticlinal pools are one example, as are also stratigraphic traps. Pools that depend on fracturing, or upon some special electric log interpretation, are others. Each idea may apply particularly well to a certain region and upon certain geologic conditions, and thereby becomes the guiding principle in the exploration of the area.

The writer will point out three of the many ideas that are being looked into and that may ultimately develop substantial new oil and gas production.

1. Unorthodox Reservoir Rocks. Geologists do not like to operate much beyond their evidence, and when the evidence is negative, they find it relatively easy to follow it and become negative in their thinking. We might say that many of us who are geologists have been undergoing a form of low-grade metamorphism over the years—a geological term that means that under relatively low pressure and temperature, the mineral grains become oriented in the same direction; they fit close together; and the chemicals from many original minerals are recomposed to form a uniform new mineral extending throughout the rock.

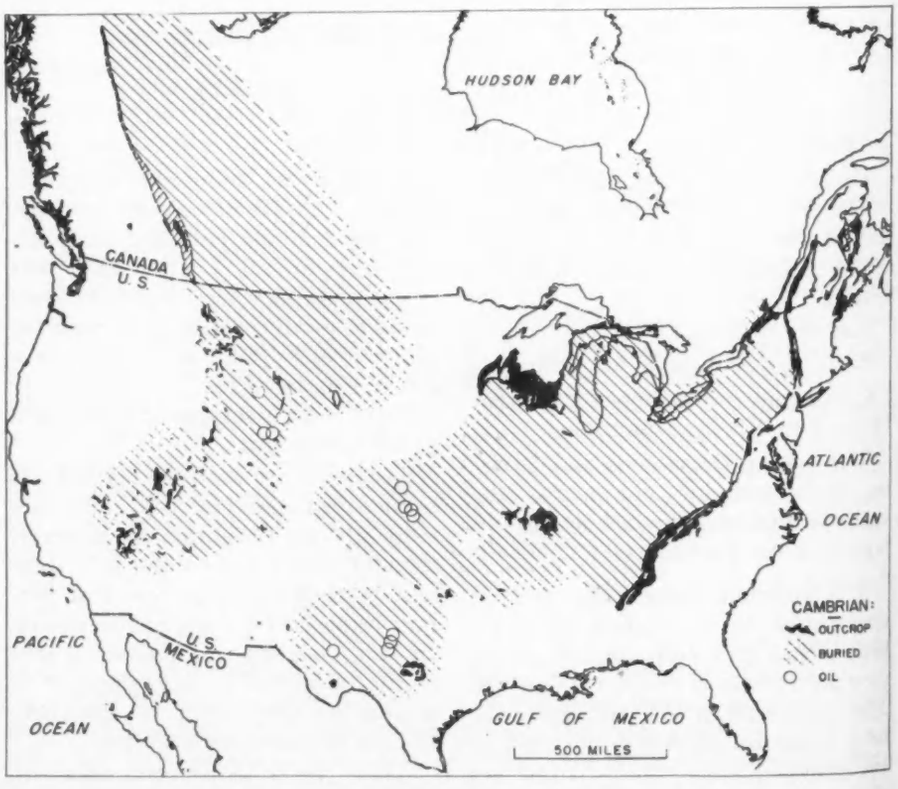


FIGURE 4

The rock now offers the greatest resistance to change. A calcite crystal in such a rock stands out like a sore thumb—it is the unmetamorphosed mineral in a metamorphosed mass. But it is in following the calcite crystal that we frequently find the ore—and maybe what we need is more calcite crystals among us geologists. We need, in fact, the unorthodox explorer.

Three kinds of rocks have in the past, for example, yielded pools where conditions were favorable—that is, where the rocks were permeable and where there was a trap, yet are generally given a low rating as potential reservoir rocks by geologists. These include: (1) The Pre-Cambrian and the basement rocks generally, igneous and metamorphic rocks such as granites, gneisses, slates, etc.; (2) the volcanic rocks such as tuffs, agglomerates, and other volcanic debris; and (3) rocks of continental or fresh-water origin.

All are present in large volumes in the U. S. and Canada, each contains oil occasionally, and each has been tested at only a relatively few places. In mentioning possible future petroleum provinces, then, areas with rocks in these categories should not be omitted.

2. Fluid Phenomena. Heretofore, geological and geophysical work has been concerned chiefly with the rocks themselves—their history, structure, density, extent, magnetics, reflecting power, etc. But we do not produce or sell the rocks or the contours, we produce and sell the fluids—oil and gas! We need to get closer to our product.

There is currently much research and investigation by the geologists on the flow of fluids in the rocks. This is a field that in the past has been the concern of the petroleum engineers, but the geologists are finding much that is helpful to them in their search for new oil and gas pools.

One application of fluid-flow phenomena is in the displaced oil pool and in the pool with a tilted oil-water contact. This concept has been explained by Hubbert, and its application promises to aid in the discovery of many overlooked oil pools, especially in regions of considerable topographic relief, as in the Rocky Mountains and California, as well as in many of the foreign regions.

Fluid-flow phenomena also aid in the search for stratigraphic traps, faults, and concealed reservoir rocks with variable permeabilities. Prospects can, in fact, be found at relatively low costs, by hydrodynamic analysis.

The most important information required for the practical application of fluid-flow phenomena is the fluid pressure in the reservoir and in the reservoir rock. It becomes probable, therefore, that exploration geologists will demand much more and better reservoir pressure data in the future than they have in the past. And in return, they should do a better job of oil-finding.

3. Complete Recovery. One of the greatest potential targets for the wildcatter in ideas in America is the development of some method of recovering the presently non-recoverable oil left behind in the primary and secondary recovery processes. In amount, it probably exceeds all of our past production. The efforts of late have been largely in the direction of heating or burning the oil in place in the ground, thereby freeing the oil from the sand and driving it toward the producing wells. Most company research organizations have some work going forward in this field and it promises to continue until a practical and economic method is discovered. Complete recovery, indeed, is more than a pious hope.

Conclusion. There still appears to be about as many possible future oil and gas provinces in sight as there ever were in the past. At no time that the writer can remember have we been able to visualize more than a fraction of the provinces that later were discovered. When we remember that most of our provinces were discovered in spite of orthodox, conventional, exploration opinion—as evidenced by the low lease prices or by the general lack of leasing in many of them—then the picture today is no worse, nor is it any better, than it was 10, 20, or 30 years ago. "It has never been so tough to find oil" is a common expression that has been repeated through the years—and we might also say, "it has never been so easy." The writer sees no lack of future supply in North America if we maintain the incentive to explore.

ACKNOWLEDGMENT

From a paper presented at the spring meeting of the Southwestern District Division of Production of the American Petroleum Institute at New Orleans, March 9-11, 1955. Original title was: "Possible Future Petroleum Provinces."

—The End

Exploration Societies

Continued from Page 75

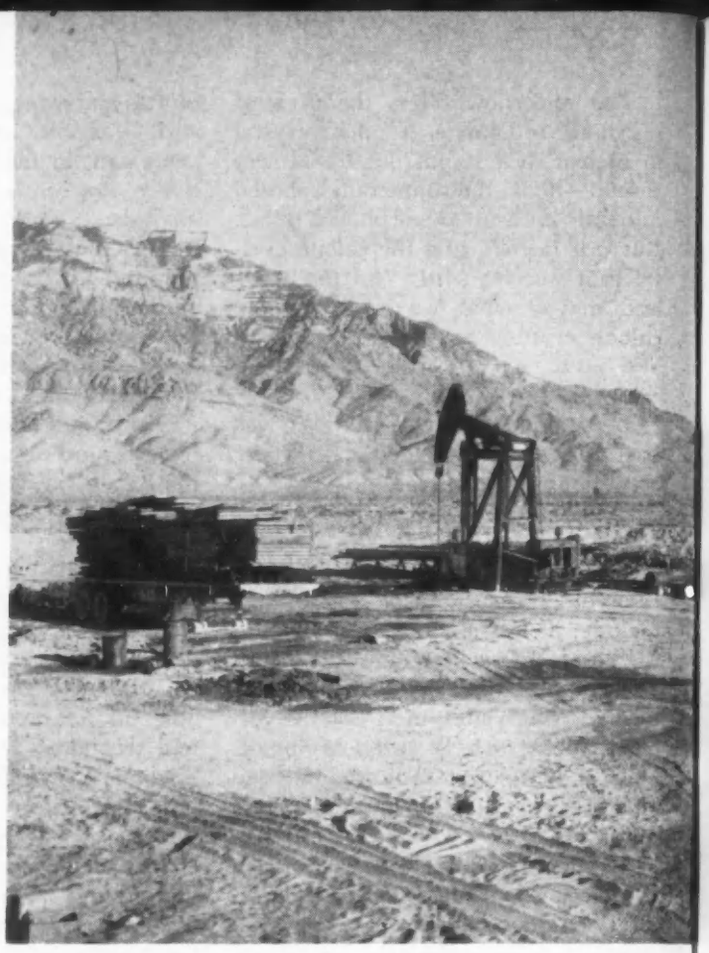
business committee and the research committee. He served as general chairman of the annual joint meeting of the three exploration societies in New York. Other professional affiliations include Geological Society of America, American Institute of Mining and Metallurgical Engineers, SEPM, SEG, advisory board of American Museum of Natural History, API Fundamental Research Committee, and Sigma Gamma Epsilon.

SEPM President Pettijohn was born June 20, 1904, in Waterford, Wis. He received his B.A., M.A. and Ph.D. degrees from the University of Minnesota, and has taught geology at Macalester College, Oberlin College, University of Minnesota, and University of Chicago, before joining the staff at Johns Hopkins University in 1952. He is a fellow of the following professional societies: American Association for the Advancement of Science, Mineralogical Society of America, and Geological Society of America. He is also a member of AAPG. He became an associate member of SEPM in 1932, transferred to active membership in 1945, and served as vice president for the 1954-1955 term.

SEG President Lyons received his B.S. degree in geology from DePauw University in 1933, and M.S. in geology from University of Tulsa in 1942. He began geophysical work with a Humble Oil & Refining Company seismograph party in 1934, and was transferred to The Carter Oil Company in Tulsa as a computer in 1935. For Carter he became chief computer in 1943 and technical geophysical supervisor in 1947. He became technical assistant to the vice president in charge of exploration in 1949 and in 1950 was staff geologist in Tulsa for Carter's Eastern division. Since 1951 he has been exploration manager for Anchor Petroleum Company, Tulsa.

Lyons has served on committees of the SEG, and as vice president and president of the Geophysical Society of Tulsa. He is a member of AAPG, Tulsa Geological Society, Geophysical Society of Tulsa, and SEG.—The End

DRILL STEM TESTING of the Cardium sand, at that time considered a not-so-promising interval, resulted in the discovery of the huge Pembina oil field of western Canada. Now comprising thousands of acres, this field may prove to be one of the largest fields in Canada. Photo shows drilling well in Pembina field near town of Drayton Valley.



PERSISTENCE AND MANY DRY HOLES were required before Nevada, once considered a none-too-encouraging area, joined the ranks of producing states. The photograph above was taken in the summer of 1954 shortly after the completion of Shell Oil Company's discovery well in Railroad Valley southwest of Ely, Nevada.

How Will Tomorrow's Oil Be Found?

The task of meeting future demand calls for aggressiveness and imagination and the drilling of more holes purely for information.

By GILBERT M. WILSON, World Oil Staff

Q. *It is apparent that we must continue to explore aggressively for new deposits of oil and gas to supply the fuel, lubricants and other petroleum products needed for our industrial growth and military requirements. We have done pretty well in the past, but what is the outlook for the future; do you think we can continue finding enough oil to meet this demand?*

A. Yes, but it will take all of our ingenuity to do so. With the exception of the offshore provinces, which as yet are barely scratched, a large percentage of the bigger and more evident accumulations of liquid hydrocarbons have already been found.

Most of the areas that are obviously favorable to generation and accumulation of oil or gas have been intensively prospected, but undoubtedly many substantial deposits have been overlooked and many others may exist in areas that do not appear particularly favorable at this time. It is interesting, for instance, to note the comparatively recent change in our attitude toward North Dakota and Nevada.

Q. *You mean since oil has been discovered in those states?*

a WORLD OIL interview

with E. B. NOBLE
Petroleum Consultant, Los Angeles

A. Yes. Now a recommendation to drill on a geological or geophysical feature in either state is given serious consideration.

Q. *Since you say we already have found a large percentage of these more evident accumulations, can you make a reasonable guess as to how much more oil there is to be found?*

A. When this question has been asked at various times during the past 10 to 20 years the classical answer has been that there probably is as much oil still to be found as has been found and produced in the past. I believe this still is the best answer.

I doubt if we ever will know when we have reached the point of diminishing returns in our oil finding effort. Curves and other forms of statistical analysis have had us at that point several times. Each time, however, something has happened to reverse the trend. Introduction of a new oil finding tool, such as the seismograph; opening of a new province, such as the Williston Basin; and recognition of the possibility of oil occurring in a new or different depositional environment, such as in the Devonion Reefs of Alberta or in the Pennsylvanian Reefs of West Texas, has been incentive enough in the past to encourage a stepup in exploratory drilling which, in turn, resulted in prolific new discoveries.

Q. *Do you foresee any new exploration tools that bear promise of contributing materially to future discoveries?*

A. No. I think we will have to make use of the tools we already have. The reflection seismograph and the core drill will probably continue to be our most reliable tools, and in some areas a combination of the two will be used to considerable advantage. Improvements will be made in geophysical instrumentation; also, operating techniques and lighter core drilling equipment will be designed for operating in remote and rugged country.

Q. *What procedure or method do you believe has more promise than any other in the discovery of new fields?*

A. Since our greatest present need is to get more subsurface information in areas where our current knowledge is sketchy, the answer seems to be: *Drill more holes purely for information.* These should be deep enough to give a comprehensive idea of the entire sedimentary section and should be carefully logged, sampled and shot for velocity control. The stimulating effect of having authentic new data to work with cannot be overemphasized.

As I see it, there are two ways of encouraging more information drilling: (1) cut drilling costs, or (2) drill this type of hole jointly or by liberal bottom hole contributions with all participants receiving the samples and other information at approximately the same time. Since these holes are not in themselves "potential oil wells," management may be more inclined to go along when several parties are to share the costs.

Many geologists have expressed the need for more information and cheaper drilling. I doubt if we can expect any drastic reduction in drilling costs, but possibly we can encourage wider distribution of factual data before it gets to be ancient history.

Q. *Would it facilitate the distribution of this factual data to have central information centers set up in the various states or areas?*

A. If what you have in mind is a central state or district depository for well samples (with microscopes and other facilities for examining

E. B. NOBLE

Except for a brief period in mining work in South America and Mexico, Noble has spent some 35 years in work related to the exploring and developing of oil and gas.

He started his oil career as a roughneck on drilling rigs in the Los Angeles Basin, then spent a year with the State Mining Bureau, Division of Oil and Gas, at Taft, California. He joined the Union Oil Company as a scout in the summer of 1923. The next 27 years were devoted to exploration work for the Union Oil Company and carried him to various parts of North and South America, Mexico and Canada. He was appointed Chief Geologist in 1937 and Manager of Exploration in 1944 and, before leaving the company to spend a year as Petroleum Consultant for the National City Bank in New York, he was Union Oil Company's General Manager for Western Canada.

Noble graduated from Yale in 1916 and did post-graduate work at the University of California at Berkeley in 1921. He is a member of various scientific and technical societies and is a past president of the American Association of Petroleum Geologists. He has been in independent consulting work since 1952 and maintains offices in Los Angeles and Bakersfield.

and describing the samples) and a library of electric logs and well histories for reference or reproduction, it would certainly be useful, particularly to the independent operator who, incidentally, is responsible for a very substantial portion of the new oil and gas discovered each year.

Q. *How can we make more use of information and logs already in our files?*

A. A periodic review of all information in our files is important. Old geophysical records should be reworked, using all presently available velocity data and all newly-acquired well information. Old well records should be carefully studied, and significant lateral variations in thickness, porosity and permeability should be noted. Lithofacies and paleofacies maps should be carefully constructed on both a local and regional basis. A thorough understanding of the environmental history of each sequence at the time of deposition will aid in recognizing conditions leading to favorable sand development, deposition of source beds, or reef build-up.

Regardless of how much data we collect, we never seem to have enough, which puts a premium on accurate recording of all important information while a well is drilling, and as far as I can see, *all* information about a well, whether it be a producer or a dry hole, is *important* information.

Every old hole that had an oil or gas showing, no matter how small, is a candidate for further study. The time when the well was drilled is important, since many of these wells were drilled without the benefit of modern coring, logging and testing devices and without our present day methods of inducing permeability by acidizing or fracturing.

Q. *Can you cite instances which illustrate the contention that we possibly are not giving adequate attention to shows recorded in the course of drilling wildcat wells?*

A. There are numerous instances where companies have drilled through what later proved to be a productive interval without recognizing its importance at the time. The discovery of the prolific Canyon Reef production of Scurry County, Texas, was made only after a re-study of the electric log. The discovery well drilled through the productive interval in search of pre-Pennsylvanian production, and apparently the electric log kickout opposite the Canyon Reef was interpreted as too weak or indefinite to justify the expense of testing.

The huge Pembina field in Western Alberta might easily have been missed if the operator had not insisted on routine tests of all porous zones. In the process of drilling to 9000 feet a routine drill stem test was made of the Cardium Sand, which at that time was considered as a possible but not very promising interval. The test was not conclusive, but when no deeper production was encountered, pipe was set on the Cardium Sand, and further testing resulted in the completion of the first Cardium Sand producer in Western Canada. This started the extensive Pembina drilling boom, which will eventually cover thousands of acres and be one of Canada's major producing areas.

Q. *Do you see encouragement in expanding the use or improving interpretation of logging?*

A. We are getting much more information from the various logging devices now in use than we did ten years ago. Gamma ray and neutron logs are especially useful in specific cases. Micrologging is a distinct help in recognizing thin zones of porosity and permeability. Mud logging units give us an excellent set of samples as well as indicating the presence of oil and gas, the percentage of sand to shale and the varying hardness of the formation drilled through by accurate time-depth readings.

Sidewall cores offer an effective method of checking the electric log, although somewhat longer cores and fewer misses would be desirable.

Q. *We have been hearing of possibly new techniques involving continuous logging. Do you regard this as an important new discovery tool?*

A. Yes. One difficulty we still have in drilling in new territory is to recognize a formational change in time to permit coring the top of a possibly productive zone. Tests now being run with experimental equipment indicate that we soon may be able to electric log a hole continuously while drilling. This would assure almost instant recognition of changing conditions and allow more effective coring and testing of the first few feet of a porous interval.

With the experience gained from extensive use of logging devices in many areas and under varying conditions, we now have many competent experts in log interpretation, and there is every reason to believe that fewer potentially productive intervals will go unnoticed or untested.

We still might hope that someone will show us the way to recognize the presence of porosity in limestones that may be only a few feet away from the dense limestone being drilled through in the bore hole. This would be particularly interesting to operators in Kansas and the reef areas of West Texas and Alberta.

Q. *Do you feel we may have just about exhausted the possibilities of finding more oil in or near salt domes?*

A. No. There are many untested salt domes known to be present in the Gulf of Mexico and, even on shore, the salt dome problem will always be with us. The complicated structural and stratigraphic conditions associated with salt uplift will prevent the geologist from ever locating all the production segments around some of these domes, particularly the piercement type domes. I don't know whether it is possible to drill enough wells

on some of these features to say that a particular dome and its immediate area has been conclusively tested.

Q. *Acknowledging the efficiency of presently-used equipment for locating anomolies, do you think we are paying sufficient attention to non-structural type accumulations, involving pinchouts and permeability barriers?*

A. Ever since Levorsen started talking about wedge edges of porosity the geological fraternity has been keenly aware of the possibility of accumulation in other than structural type traps. Much of our subsurface study is designed to point a finger in the direction of improving sand conditions; to measure the lateral variations in thickness of various stratigraphic units; to watch for changes in porosity, and to recognize permeability barriers.

Studies related to depositional facies are becoming increasingly important, and there is a growing awareness of the part played by turbidity currents which may account for off-structure accumulations in the most unexpected places. The recent discovery in California of a 65-foot oil sand within the Gatchell Sand interval, which resulted in the surprising completion of a 3000 barrels per day well, after two wet formation tests in the upper part of the Gatchell Sand, may be partly due to the effect of turbidity currents. This well marks the discovery of what is now known as the Polvadero field.

Q. *Do you know of any approach which might result in the more efficient use of geologists and other staff personnel?*

A. It seems to me the so-called "exploration team" is a logical approach to more efficient oil finding procedure. A group of hand-picked specialists, comprising experienced geologists, paleontologists, stratigraphers and geophysicists should get the best results, whether it is a preliminary study of a new province or a specific problem in a limited area. A small mobile drilling unit could be put at their disposal to drill information holes wherever subsurface information would help in the solution of their problem. They would work under the general supervision of the Chief Geologist or Manager of Exploration, but would have a reasonably free hand in carrying out their assignment. Deep exploratory holes would follow their recommendations. So that they might feel the faith placed in them and recognize their own responsibility to each other and to the company, the directive to the group might read: "This is your area; stick to it until you find some oil."

Q. *In selecting men for one of these exploration teams, which is more important: training or personality?*

A. Sound training at the "collegiate" level is important, but not as important as the wide experience gained in tackling difficult problems in various areas for 10 or 15 years after graduation. Since the group is to work together indefinitely, the men must be cooperative and have the good old school spirit of "do or die" for the team. The prima donna type geologist could wreck a team, but can be used to great advantage on lone assignments.

Team members should have an open mind and plenty of imagination and not be bound by text book or hide-bound ideas, as long as their thinking is based on sound geological reasoning and does not violate well authenticated factual data. Our profession has great need for men with imagination, but in my opinion modern mass educational methods tend to suppress rather than encourage this quality.

Q. *We hear a lot about public relations. Do you believe enough emphasis is being placed upon educating the public relative to our exploration problems?*

A. No. I believe much more effort should be made to acquaint the layman and particularly city, county, state and federal bodies in regard to our specific problems. Often, politically-inspired and even well-intentioned legislation and regulation seriously affect our exploration program. The present restrictions pertaining to prospecting off the California Coast is a good example. Also, we find that a number of areas having known oil possibilities are closed to us when zoned against drilling, due to residential or industrial growth.

Our exploration effort is often stymied by prohibitive bonuses and royalties, particularly in areas where production must come from thin pay zones at great depths. It may take 20 or 30 or even more wildcats to find a substantial accumulation of oil. Considering these odds, the operator has to work within limits that will allow him to make a reasonable profit when he does hit. I have heard of people playing roulette with the hope of getting 35 to 1 when their number shows up, but I have never heard of of anyone paying a bonus to the house for playing.

We occasionally find that some oil companies, also some of our larger landowners, have a rather inactive policy in exploring or developing fee lands or those held under long-term, low-rental leases. I do not know just what the answer is in this case, but probably a more liberal farmout policy on the part of the companies would help. In addition, sliding-scale royalties reflecting the economics of depth, together with realistic rentals and bonuses, would go a long way toward making more untested land available for exploration.

Q. *This discussion has brought out some interesting and stimulating thoughts. Would you care to make a concluding statement?*

A. Yes. I believe that we are going to find a lot more oil, but we can't do it without drilling wells. There has always been a rather close relationship between the number of exploratory wells drilled and the amount of new oil found, so any time-saving technique or other device that will contribute toward reducing drilling costs will be a real contribution to our exploratory effort. —**The End**

U.S. and Canadian Reserves at New Peaks

Estimated U. S. Reserves of Natural Gas, by Years

Source: American Gas Association

(Millions of Cubic Feet—14.65 psia, at 60 deg. F.)

YEAR	NATURAL GAS ADDED DURING YEAR: Extensions and Revisions	Discoveries of New Fields and New Pools in Old Fields	Total of Discoveries, Revisions and Extensions	Net Change in Storage	Net Production During Year	Estimated Proved Reserves as of End of Year	Increase Over Previous Year
1945	.....	.....	.....	.....	.....	147,789,366	.....
1946	*	*	17,729,152	*	4,942,617	160,575,901	12,786,535
1947	7,570,654	3,410,170	10,980,824	*	5,629,811	165,926,914	5,351,013
1948	9,769,483	4,129,089	13,898,572	51,482	6,007,638	173,869,340	7,942,426
1949	8,061,429	4,612,870	12,674,299	82,764	6,245,041	180,381,344	6,512,004
1950	9,172,381	2,877,351	12,049,732	54,301	6,892,678	185,592,699	5,211,355
1951	13,013,606	3,039,385	16,052,991	132,751	7,966,941	193,811,500	8,218,801
1952	8,934,470	5,411,043	14,345,513	198,850	8,639,638	199,716,225	5,904,725
1953	13,371,355	7,081,661	20,453,016	†516,431	9,238,540	211,447,132	11,730,907
1954	4,632,309	4,966,894	9,599,203	90,906	9,426,509	211,710,732	263,600

* Not estimated.
† All native gas in storage reservoirs formerly classified as a natural gas reserve is included in this figure.

Estimated Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons, by Years

Sources: Crude Oil by API; Natural Gas Liquids by API and AGA

(THOUSANDS OF BARRELS)

YEAR	NEW OIL ADDED DURING YEAR: Through Revisions of Previous Estimates and Extensions, to Known Fields (1)	Through Discoveries of New Fields and of New Pools in Old Fields (2)	Total Through New Discoveries, Extensions, and Revisions (Columns 1 + 2) (3)	Production During Year (4)	Estimated Proved Reserves as of End of Year (Columns 3 – 4) (5)	Increase Over Previous Year (6)
Crude Oil (Incl. Cycle Plant and Lease Condensate)						
1936	.....	.....	.....	.....	13,063,400	.....
1937	2,792,790	928,742	3,721,532	1,277,664	15,507,268	2,443,868
1938	2,243,571	810,493	8,054,064	1,213,186	17,348,146	1,840,878
1939	2,058,455	340,667	2,399,122	1,264,256	18,483,012	1,134,866
1940	1,607,012	286,338	1,893,350	1,351,847	19,024,515	541,503
1941	1,538,989	429,974	1,968,963	1,404,182	19,589,296	564,781
1942	1,618,925	260,051	1,878,976	1,385,479	10,082,793	493,497
1943	1,202,368	282,418	1,484,786	1,503,427	20,064,152	(—) 18,641
1944	1,556,192	511,308	2,067,500	1,678,421	20,453,231	389,079
1945	1,690,315	419,984	2,110,299	1,736,717	20,826,813	373,582
Crude Oil Only						
1944	.....	.....	.....	.....	19,784,530	.....
1945	.....	.....	.....	.....	19,941,846	.....
1946	2,413,628	244,434	2,658,062	1,726,348	20,873,560	931,714
1947	2,019,140	445,430	2,464,570	1,850,445	21,487,685	614,125
1948	3,398,726	396,481	3,795,207	2,002,448	23,280,444	1,792,759
1949	2,297,428	890,417	3,187,845	1,818,800	24,649,489	1,369,045
1950	1,997,769	564,916	2,562,685	1,943,776	25,268,398	618,909
1951	4,024,698	389,256	4,413,945	2,214,321	27,468,031	2,199,633
1952	2,252,860	496,428	2,749,288	2,256,765	27,960,554	492,523
1953	2,704,450	591,680	3,296,130	2,311,856	28,944,828	984,274
1954	2,287,231	585,806	2,873,037	2,257,119	29,560,746	615,918
Natural Gas Liquids (Condensate, Natural Gasoline and Liquefied Petroleum Gases)						
1946	.....	.....	.....	.....	3,163,219	.....
1947	192,237	59,301	251,538	160,782	3,253,975	90,756
1948	405,874	64,683	470,557	183,749	3,540,783	286,808
1949	294,211	92,565	386,776	198,547	3,729,012	188,229
1950	707,879	58,183	766,062	227,411	4,267,663	538,651
1951	648,497	75,494	723,991	267,052	4,724,602	456,939
1952	475,170	81,668	556,838	284,789	4.996,651	272,049
1953	648,074	95,922	743,969	302,698	5,437,922	441,271
1954	20,830	86,520	107,350	300,815	5,244,457	(—)193,465
Total Liquid Hydrocarbons (Crude Oil and Natural Gas Liquids)						
1946	.....	.....	.....	.....	24,036,779	.....
1947	2,211,377	504,731	2,716,108	2,011,227	24,741,660	704,881
1948	3,804,600	461,164	4,265,764	2,186,197	26,821,227	2,079,567
1949	2,591,639	982,982	3,574,621	2,017,347	28,378,501	1,557,274
1950	2,705,648	623,099	3,328,747	2,171,187	29,536,061	1,157,560
1951	4,673,195	464,750	5,137,945	2,481,373	32,192,633	2,656,572
1952	2,728,030	578,096	3,306,126	2,541,554	32,957,205	764,572
1953	3,352,497	687,602	4,040,099	2,614,554	34,382,750	1,425,545
1954	2,308,061	672,326	2,980,387	2,557,934	34,805,203	422,453

More oil and natural gas proved up than produced during 1954.

By L. J. LOGAN
WORLD OIL STAFF

U. S. RESERVES of liquid hydrocarbons and natural gas were further increased in 1954 and stood at new highs at the end of the year. Canada's reserves of liquid hydrocarbons also climbed to new peaks. However, the results in the U. S. were the least successful for any year since World War II, in spite of record drilling and record wildcatting.

The net increases in U. S. reserves of both liquid hydrocarbons and natural gas were the smallest since the war. Crude reserves were increased a little more than in 1952 and about the same as in 1947 and 1950 but less than in other postwar years. U. S. reserves of natural gas liquids showed a substantial decrease rather than an increase, whereas they had consistently increased in all other postwar years. U. S. reserves of natural gas barely showed a net increase, with additions only slightly exceeding production during the year. In other postwar years, natural gas reserves had been expanding materially each year.

In Canada, there was in 1954 a comparatively large increase in liquid hydrocarbon reserves—a larger gain than in 1953.

These salient facts about reserves in the U. S. and Canada were revealed at mid-March when the American Petroleum Institute and the American Gas Association made public the annual estimates of their geological committees on reserves. The data on Canadian reserves were obtained by the API from the general reserves committee of the Canadian Petroleum Association.

U. S. Liquid Hydrocarbons. Proved reserves of liquid hydrocarbons in the

U. S. were estimated at 34,805,203,000 barrels at end of 1954. That was a net increase of 422,453,000 barrels over the reserves at end of 1953. This increase was achieved by proving up during the year 2,980,387,000 barrels of new reserves while production amounted to 2,557,934,000 barrels. The net gain of 422 million barrels in 1954 was the smallest annual increase since 1945, when there was far less drilling. In other postwar years the net increases ranged from 700 million in 1947 to 2.6 billion barrels in 1951.

The 2,980,387,000 barrels of new liquid hydrocarbon reserves proved up in 1954 compared with a postwar low of 2.7 billion barrels proved in 1947 and a postwar high of 5.1 billion barrels proved up in 1951.

Crude Oil. Included in the U. S. liquid hydrocarbon reserves at end of

Summary of Changes in 1954 in Proved U. S. Reserves of Liquid Hydrocarbons

Sources: Crude oil from API; natural gas liquids from API and AGA

(THOUSANDS OF BARRELS)

CRUDE OIL		
Total proved reserves Dec. 31, 1953		28,944,828
Revisions of previous estimates	+537,788	
Extensions of old pools	1,749,443	
New reserves discovered in 1954 in new fields and in new pools in old fields	585,806	
Proved reserves added in 1954		2,873,037
Total proved reserves Dec. 31, 1953 plus new proved reserves added in 1954		31,817,865
Less production during 1954*		2,257,119
Total proved reserves Dec. 31, 1954		29,560,746
Increase in reserves during 1954		615,918
NATURAL GAS LIQUIDS		
Total proved reserves Dec. 31, 1953		5,437,922
Revisions of previous estimates and extensions of old pools	+20,830	
New reserves discovered in 1954 in new fields and in new pools in old fields	86,520	
Proved reserves added in 1954		107,350
Total proved reserves Dec. 31, 1953 plus new proved reserves added in 1954		5,545,272
Less production during 1954*		300,815
Total proved reserves Dec. 31, 1954		5,244,457
Increase in Natural Gas Liquids reserves during 1954		(—)193,465
TOTAL LIQUID HYDROCARBONS		
Total proved reserves Dec. 31, 1953		34,382,750
Revisions of previous estimates and extensions of old pools	+2,308,061	
New reserves discovered in 1954 in new fields and in new pools in old fields	672,326	
Proved reserves added in 1954		2,980,387
Total proved reserves Dec. 31, 1953 plus new proved reserves added in 1954		37,363,137
Less production during 1954*		2,557,934
Total proved reserves Dec. 31, 1954		34,805,203
Increase in Total Liquid Hydrocarbon reserves during 1954		422,453

* The 1954 production figures were compiled by the committee from records of actual production for whatever period such were available, with estimates for the remainder of the year. Any variance between the actual production, as later reported, and the figures used herein will be compensated for through revision when the following year's reserve report is compiled. These revisions have in the past been very small. Because, in each annual report by this committee, the production figure for the year is an estimate, as just explained, correct total cumulative production cannot be obtained by adding together the figures listed in successive reports of this committee.

Estimated Proved Reserves of Liquid Hydrocarbons in U. S. and Canada, by Areas

Sources: For U. S., crude oil from API and natural gas liquids from API and AGA. For Canada, all data via API from Canadian Petroleum Association.

(THOUSANDS OF BARRELS)

STATE or PROVINCE	Proved Reserves Dec. 31, 1953 (1)	Added in 1954 by Extensions and Revisions (2)	[1]Discovered in 1954 in New Fields and in New Pools in Old Fields (3)	[11]Production During 1954 (4)	Reserves Dec. 31, 1954 (Columns 1 + 2 + 3 Less Column 4) (5)	Net Change in Reserves During 1954 (Column 5 Less Column 1) (6)
UNITED STATES						
Crude Oil						
Alabama	17,160	(—)17	.....	1,578	15,565	(—)1,595
Arkansas	358,231	17,802	1,944	26,557	351,420	(—)6,811
[2]California	3,919,379	298,729	26,345	355,865	3,888,588	(—)30,791
Colorado	319,254	27,554	27,772	45,929	328,651	9,397
Illinois	624,803	96,162	3,202	65,756	658,411	33,608
Indiana	62,128	15,091	1,179	11,215	67,183	5,055
Kansas	913,341	155,163	28,182	118,237	978,449	65,108
Kentucky	81,655	13,813	3,117	13,244	85,341	3,686
[2]Louisiana	2,759,655	276,150	152,541	226,695	2,961,651	201,996
Michigan	60,721	9,601	1,242	11,944	59,620	(—)1,101
Mississippi	350,101	88,302	6,528	32,655	412,276	62,175
Montana	208,985	75,837	1,604	14,032	272,394	63,409
Nebraska	25,621	10,833	9,615	8,038	38,031	12,410
New Mexico	814,902	55,647	8,131	72,794	805,886	(—)9,016
New York	49,083	.....	.....	3,252	45,831	(—)3,252
North Dakota	128,271	10,384	1,814	6,120	134,349	6,078
Ohio	31,826	8,833	.....	3,887	36,772	4,946
Oklahoma	1,752,228	353,802	32,932	183,614	1,955,348	203,120
Pennsylvania	111,083	.....	.....	9,234	101,849	(—)9,234
[2]Texas	14,998,620	680,293	254,935	951,845	14,982,003	(—)16,617
Utah	37,937	227	166	1,916	36,414	(—)1,523
West Virginia	36,612	2,700	900	2,900	37,312	700
Wyoming	1,279,110	90,313	23,237	89,083	1,303,577	24,467
[3]Miscellaneous	4,122	12	420	729	3,825	(—)297
Total United States	28,944,828	2,287,231	585,806	2,257,119	29,560,746	615,918
[4]**Natural Gas Liquids**						
[5]Alabama	.....	.....	.....	.....	.....	.....
Arkansas	49,585	(—)798	45	1,913	46,919	(—)2,666
[2]California	324,866	33,848	2,350	30,815	330,249	5,383
Colorado	10,689	2,718	13	673	12,747	2,058
Illinois	17,043	8,464	405	3,692	22,220	5,177
Indiana	145	37	2	33	151	6
Kansas	177,728	285	2,448	5,264	175,197	(—)2,531
Kentucky	7,776	5,304	152	2,492	10,740	2,964
[2]Louisiana	813,214	86,925	19,220	35,313	884,046	70,832
Michigan	641	271	79	78	913	272
Mississippi	54,734	7,470	942	2,726	60,420	5,686
Montana	2,908	4,571	.....	300	7,179	4,271
Nebraska	3,034	(—)726	83	123	2,268	(—)766
New Mexico	320,657	28,904	3,576	13,146	339,991	19,334
Ohio	1,359	90	9	19	1,439	80
Oklahoma	304,232	51,375	6,628	28,324	333,911	29,679
Pennsylvania	2,768	156	78	133	2,869	101
[2]Texas	3,267,242	(—)220,506	49,924	168,523	2,928,137	(—)339,105
Utah	53	(—)2	.....	4	47	(—)6
West Virginia	28,213	10,635	212	5,066	33,994	5,781
Wyoming	50,559	1,809	354	2,036	50,686	127
[6]Miscellaneous	476	.....	.....	142	334	(—)142
Total United States	5,437,922	20,830	86,520	300,815	5,244,457	(—)193,465
[7]**Total Liquid Hydrocarbons**						
[8]Alabama	17,160	(—)17	.....	1,578	15,565	(—)1,595
Arkansas	407,816	17,004	1,989	28,470	398,339	(—)9,477
[2]California	4,244,245	332,577	28,695	386,680	4,218,837	(—)25,408
Colorado	329,943	30,272	27,785	46,602	341,398	11,455
Illinois	641,846	104,626	3,607	69,448	680,631	38,785
Indiana	62,273	15,128	1,181	11,248	67,334	5,061
Kansas	1,091,069	155,448	30,630	123,501	1,153,646	62,577
Kentucky	89,431	19,117	3,269	15,736	96,081	6,650
[2]Louisiana	3,572,869	363,075	171,761	262,008	3,845,697	272,828
Michigan	61,362	9,872	1,321	12,022	60,533	(—)829
Mississippi	404,835	95,772	7,470	35,381	472,696	67,861
Montana	211,893	80,408	1,604	14,332	279,573	67,680
Nebraska	28,655	10,107	9,698	8,161	40,299	11,644
New Mexico	1,135,559	84,551	11,707	85,940	1,145,877	10,318
[8]New York	49,083	.....	.....	3,252	45,831	(—)3,252
[8]North Dakota	128,271	10,384	1,814	6,120	134,349	6,078
Ohio	33,185	8,923	9	3,906	38,211	5,026
Oklahoma	2,056,460	405,177	39,560	211,938	2,289,259	232,799
Pennsylvania	113,851	156	78	9,367	104,718	(—)9,133
[2]Texas	18,265,862	459,787	304,859	1,120,368	17,910,140	(—)355,722
Utah	37,990	225	166	1,920	36,461	(—)1,529
West Virginia	64,825	13,335	1,112	7,966	71,306	6,481
Wyoming	1,329,669	92,122	23,591	91,119	1,354,263	24,594
[9]Miscellaneous	4,598	12	420	871	4,159	(—)439
Total United States	34,382,750	2,308,061	672,326	2,557,934	34,805,203	422,453
CANADA						
Crude Oil						
Northwest Territories	26,442	100	.....	370	26,172	(—)270
Alberta	1,624,496	374,533	16,835	87,385	1,928,479	303,983
Saskatchewan	182,159	(—)15,109	60,614	5,299	222,365	40,206
Manitoba	10,890	(—)300	20,670	2,133	29,127	18,237
Ontario and New Brunswick	1,435	365	100	429	1,471	36
Total Crude Oil	1,845,422	359,589	98,219	95,616	2,207,614	362,192
[10]Natural Gas Liquids	198,126	(—)9,632	21,285	1,448	208,331	10,205
Total Liquid Hydrocarbons	2,043,548	349,957	119,504	97,064	2,415,945	372,397

[1] Limited area assigned to a discovery until proved larger. [2] Includes off-shore reserves. [3] Fla., Mo., Nev., S.D., Tenn., Va. [4] Condensate, natural gasoline, LPG. [5] Incl. in Misc. [6] Ala., Fla., N.D. [7] Crude oil and natural gas liquids. [8] Crude oil only. [9] Ala. and N.D. natural gas liquids; Mo., Nev., S.D., Tenn., and Va. crudes; and Fla. crude and natural gas liquids. [10] All in Alta. and Br. Columbia. [11] See footnote in adjacent column.

1954 were 29,560,746,000 barrels of crude oil. That amount was an increase of 615,918,000 barrels over reserves held at end of 1953. The gain was achieved by proving up 2,873,037,000 barrels of new reserves during 1954 while production amounted to 2,257,119,000 barrels. In other postwar years the annual net increases in crude reserves have ranged from about 500 million barrels in 1952 to 2.2 billion barrels in 1951.

Estimated Proved Recoverable Reserves of Natural Gas in U. S., by States

Source: American Gas Association

(Millions of Cubic Feet—14.65 psia at 60 deg. F.)

		CHANGES IN RESERVES DURING 1954				[1]RESERVES AS OF DEC. 31, 1954				
STATE	[1]Reserves as of Dec. 31, 1953	[1]Extensions and Revisions	[1]Discoveries of New Fields and New Pools in Old Fields	[2]Net Change in Underground Storage	[3]Net Production	Total (Columns 7+8+9+10, Also Columns 1+2+3+4 Less Column 5)	[4]Non-Associated	[5]Associated	[6]Dissolved	[7]Underground Storage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Arkansas	1,211,266	—19,422	3,872	1,689	32,026	1,165,379	517,112	361,927	279,437	6,903
[8]Calif.	9,159,347	287,939	59,110	—11,255	468,538	9,026,603	2,270,399	2,120,603	4,583,222	52,379
Colorado	1,864,275	—49,945	174,374	0	55,791	1,932,913	1,173,662	57,097	702,154	0
Illinois	231,251	33,206	4,048	19,802	34,551	253,756	2,500	9,863	221,591	19,802
Indiana	35,830	7,258	285	—1,274	6,050	36,049	2,350	2,802	25,433	5,464
Kansas	15,787,602	179,140	233,601	10,768	452,779	15,758,332	15,149,660	214,253	342,457	51,962
Kentucky	1,301,533	44,815	10,340	1,919	72,000	1,286,607	1,208,155	0	57,133	21,319
[8]Louisiana	34,458,912	2,595,319	1,252,836	0	1,507,081	36,799,986	29,276,768	4,939,363	2,583,855	0
Michigan	275,519	37,163	7,961	19,093	9,636	330,100	31,194	20,000	65,703	213,203
Miss.	2,569,181	361,267	8,750	159	166,674	2,772,683	2,029,557	478,232	264,082	812
Montana	764,000	—31,127	22,674	1,179	32,995	723,731	576,628	33,262	83,555	30,286
Nebraska	182,110	6,742	17,009	0	12,915	192,946	112,003	13,960	66,983	0
N. Mexico	17,522,210	—331,033	549,760	—26,636	473,632	17,240,669	13,703,708	1,720,055	1,745,829	71,077
New York	71,004	298	0	1,913	3,853	69,362	38,962	0	403	29,997
Ohio	755,982	27,859	8,780	13,651	31,531	774,741	506,483	0	29,723	238,535
Oklahoma	12,228,373	771,691	247,151	6,914	857,981	12,396,148	6,563,227	2,014,666	3,736,573	81,682
Penna.	751,844	72,034	21,325	45,010	158,050	732,163	439,503	0	34,728	257,932
[8]Texas	106,529,626	1,278,190	2,078,659	6,002	4,763,415	105,129,062	68,536,351	20,856,529	15,722,881	13,301
Utah	1,113,058	—716,993	7,733	0	16,423	387,375	384,543	0	2,832	0
W. Va.	1,653,942	100,743	22,000	104	169,499	1,607,290	1,384,056	0	57,116	166,118
Wyoming	2,739,631	—27,018	229,019	1,868	88,429	2,855,071	2,095,562	153,495	586,158	19,856
[9]Misc.	240,636	4,183	7,607	0	12,660	239,766	73,686	0	166,080	0
Total	211,447,132	4,632,309	4,966,894	90,906	9,426,509	211,710,732	146,076,069	32,996,107	31,357,928	1,280,628

[1] Excludes gas loss due to natural gas liquids recovery.
[2] The net difference between gas stored in and gas withdrawn from underground storage reservoirs, inclusive of adjustments and native gas transferred from other reserve categories.
[3] Net production equals gross withdrawls less gas injected into producing reservoirs. Changes in underground storage and gas loss due to natural gas liquids recovery are excluded. Fourth quarter production estimated in some instances.
[4] Non-associated gas is free gas not in contact with crude oil in the reservoirs.
[5] Associated gas is free gas in contact with crude oil in the reservoirs.
[6] Dissolved gas is gas in solution with crude oil in the reservoirs.
[7] Gas held in underground reservoirs (including native and net injected gas) for storage purposes.
[8] Includes off-shore reserves.
[9] Includes Alabama, Arizona, Florida, Maryland, Missouri, North Dakota, and Virginia.

Estimated Proved Recoverable Reserves of Natural Gas Liquids in U. S., by States

(Includes Condensate, Natural Gasoline, and Liquefied Petroleum Gas)

(THOUSANDS OF BARRELS)

		CHANGES IN RESERVES DURING 1954			RESERVES AS OF DECEMBER 31, 1954			
STATE	Reserves as of Dec. 31, 1953	Extensions and Revisions	Discoveries of New Fields and New Pools in Old Fields	[1]Net Production	Total (Columns 6+7+8, Also Columns 1+2+3 Less Column 4)	Non-Associated	Associated	Dissolved
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Arkansas	49,585	(—)798	45	1,913	46,919	19,141	14,080	13,698
[2]California	324,866	33,848	2,350	30,815	330,249	0	104,137	226,112
Colorado	10,689	2,718	13	673	12,747	2,367	209	10,171
Illinois	17,043	8,464	405	3,692	22,220	47	13	22,160
Indiana	145	37	2	33	151	14	11	126
Kansas	177,728	285	2,448	5,264	175,197	169,713	2,060	3,424
Kentucky	7,776	5,304	152	2,492	10,740	10,740[3]	0	0
[2]Louisiana	813,214	86,925	19,220	35,313	884,046	707,436	127,908	48,702
Michigan	641	271	79	78	913	156	100	657
Mississippi	54,734	7,470	942	2,726	60,420	33,528	21,346	5,546
Montana	2,908	4,571	0	300	7,179	33	0	7,146
Nebraska	3,034	(—)726	83	123	2,268	1,542	391	335
New Mexico	320,657	28,904	3,576	13,146	339,991	223,966	26,472	89,553
Ohio	1,359	90	9	19	1,439	1,439[3]	0	0
Oklahoma	304,232	51,375	6,628	28,324	333,911	110,825	38,226	184,860
Pennsylvania	2,768	156	78	133	2,869	2,869[3]	0	0
[2]Texas	3,267,242	(—)220,506	49,924	168,523	2,928,137	1,313,119	420,926	1,194,092
Utah	53	(—)2	0	4	47	47	0	0
West Virginia	28,213	10,635	212	5,066	33,994	33,994[3]	0	0
Wyoming	50,559	1,809	354	2,036	50,686	17,623	1,117	31,946
[4]Miscellaneous	476	0	0	142	334	0	0	334
Total	5,437,922	20,830	86,520	300,815	5,244,457	2,648,599	756,996	1,838,862

[1] Fourth quarter production estimated in some instances.
[2] Includes off-shore reserves.
[3] Not allocated by types but occurring principally in the column shown.
[4] Alabama, Florida, and North Dakota.

The total of 2,873,037,000 barrels of crude reserves proved up in 1954 compared with a postwar low of 2.5 billion barrels proved in 1947 and a postwar high of 4.4 billion barrels proved up in 1951.

The U. S. crude reserves at end of 1954 were equivalent to 13.1 times the production of 2,257,119,000 barrels during 1954. Because production showed a decrease instead of the usual increase, this ratio was higher than for the preceding three years, when it held around 12.4.

Natural Gas Liquids. U. S. reserves of natural gas liquids at end of 1954 were estimated at 5,244,457,000 barrels, a decrease of 193,465,000 barrels from the end of 1953. New reserves proved up during 1954 totaled only 107,350,000 barrels, while production amounted to 300,815,000 barrels. In all other postwar years there were net increases in these reserves, ranging from 90 million to 539 million barrels annually, as new reserves proved up varied from 252 million to 766 million barrels per year.

Natural Gas. U. S. reserves of natural gas were estimated by AGA at 211.7 trillion cubic feet at end of 1954, an increase of 263 billion over a year earlier. Compared with this net gain of only ¼ trillion feet in 1954, there were gains in other postwar years ranging from 5 to 12 trillion cubic feet annually.

Canada. Reserves of liquid hydrocarbons in Canada at end of 1954 were estimated at 2,415,945,000 barrels, an increase of 372,397,000 from a year before. New reserves proved up in 1954 amounted to 469,461,000 barrels while production totaled 97,064,000 barrels. The present Canadian reserves, located largely in Western Canada, include 2,207,614,000 barrels of crude and 208,331,000 barrels of natural gas liquids.

Summary of Changes in 1954 in Proved U. S. Reserves of Natural Gas

Source: American Gas Association

(MILLIONS OF CUBIC FEET)

Total proved reserves Dec. 31, 1953		211,447,132
Extensions and revisions of previous estimate during the year of 1954	4,632,309	
New reserves discovered in 1954	4,966,894	
Net changes in "stored gas" in 1954	90,906	
Total proved reserves added and net changes in "stored gas" during 1954		9,690,109
Total proved reserves as of Dec. 31, 1953 and additions during 1954		221,137,241
Deduct production during 1954		9,426,509
Total proved reserves of natural gas as of December 31, 1954		211,710,732
Increase in reserves during 1954		263,600

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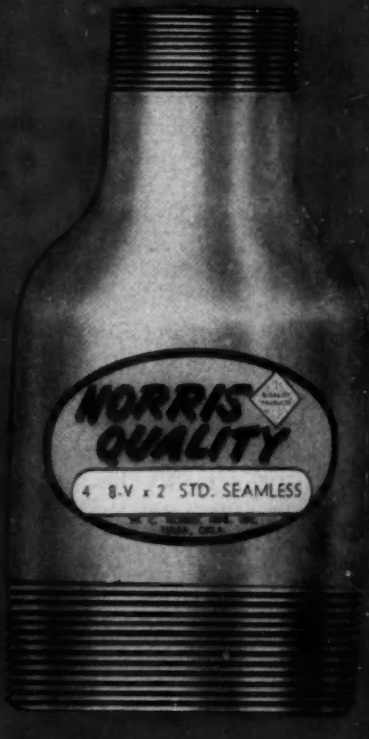

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THE CHANGING PANORAMA

WORLD OIL's Views of the News

- Harris bill to amend gas act is pushed . . . • Productive capacity debate ahead.
- U. S. strikes it rich with offshore leasing . . . • Union seeks second pay hike.
- Texas compensation legislation nearer . . . • Hearings held on imports problem.

Gas Fight Aid Mustered

"The importance of energy to a strong and growing economy is clear."

So stated the introduction to the report on energy supplies and resources made by President Eisenhower's advisory committee headed by Defense Mobilizer Arthur S. Fleming and composed of seven cabinet members.

The committee believes . . .

The federal government should not control the production, gathering, processing or sale of natural gas prior to its entry into interstate transmission lines . . .

Production and conservation of natural gas should be regulated by state conservation commissions . . .

Interstate transmission of natural gas should be regulated by the Federal Power Commission . . .

Local distribution of natural gas should be regulated by local public utility commissions . . .

The power of eminent domain should be granted for the acquisition of surface and mineral rights for development of underground storage reservoirs for natural gas . . .

If the imports of crude and residual oils should exceed signficantly the respective proportions that these imports of oil bore to production of domestic crude oil in 1954, appropriate action should be taken . . .

The Defense and Interior departments should make studies to determine the need for any measures to maintain refinery capacity necessary for defense purposes, particularly the capacity operated by small, independent refineries . . .

Present tax provisions on coal, oil and gas production have been an important factor in encouraging development of energy sources at a pace about in keeping with demand . . .

The report was a clear mandate to Congress for legislation reversing the Supreme Court's 1954 decision placing gas producers who sell to interstate pipe lines under the jurisdiction of the Federal Power Commission.

The industry was quick to gather support for a bill introduced in early March by Rep. Oren Harris, Arkansas Democrat, that would carry out the recommendations of the committee removing production, gathering, field processing and field sales of natural gas prior to its entry into interstate pipe lines from FPC control.

Harris is the ranking Democratic member of the House Commerce Committee, which began hearings on his bill late in March, and is chairman of the subcommittee which has jurisdiction over FPC. It was his bill that passed the House in 1950, only to be vetoed by President Truman.

Harris consulted with Speaker Sam Rayburn and obtained his approval of the bill before dropping it in the hopper.

The Harris bill, which differs from about a dozen others only in phraseology, would limit FPC authority to gas sales after delivery to interstate lines. All production, gathering, processing, treating and compressing in the producing field or vicinity would be exempt. The bill also declares that when an interstate gas company seeks a rate hike on the basis of a new contract to buy gas from a non-affiliate, FPC shall allow as an operating expense the reasonable market price in the field, plus a fair gathering charge. The same price should also be permitted in cases of proposed rate hikes covering gas which an interstate gas company produces itself through a subsidiary or buys from an affiliate. An affiliate is defined as a corporation which controls, is controlled by, or is under common control with the interstate company.

The bill further declares that FPC must not allow as an operating expense any price paid for gas greater than the reasonable market price in the field, plus a fair gathering charge in cases where this is not included in the market price.

Harris assured the House that the bill provides protection for the consumer by establishing a fair basis for determining gas company rates.

Production Debate Ahead

Washington sources predict a warm debate on U. S. productive capacity upon release of a report by the McCollum Committee of the National Petroleum Council. Sent to the Council in January the study was referred back to the Committee for additional consideration.

Adoption is expected at the May 5 meeting. The initial study found that domestic productive capacity of crude and natural gas liquids as of July 1, 1954, amounted to 9,096,000 barrels daily. This would indicate reserve productive capacity of 2,212,000 barrels daily over July average production, and 1,936,000 barrels daily over June, 1954.

It was reported that crude availability in the U. S. in mid-1954 amounted to 8,331,000 barrels daily (2,089,000 in reserve capacity), and natural gas liquids availability averaged 765,000 barrels daily (123,000 barrels daily in reserve capacity).

It was pointed out that the rate of increase in reserve capacity has grown sharply in the past two years, and that in the 18 months since the previous NPC study, total availability of all oils increased by 937,000 barrels daily.

U. S. Productive availability at mid-1954 was considerably higher than the estimated 7.8—8.8 million barrels daily range that the previous NPC committee study had predicted would be reached by the end of 1955. It was also higher than the level of produc-

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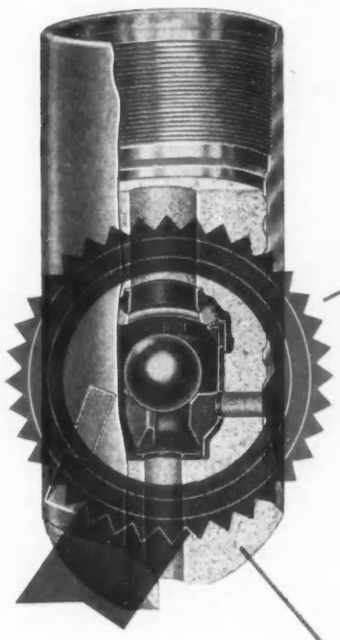

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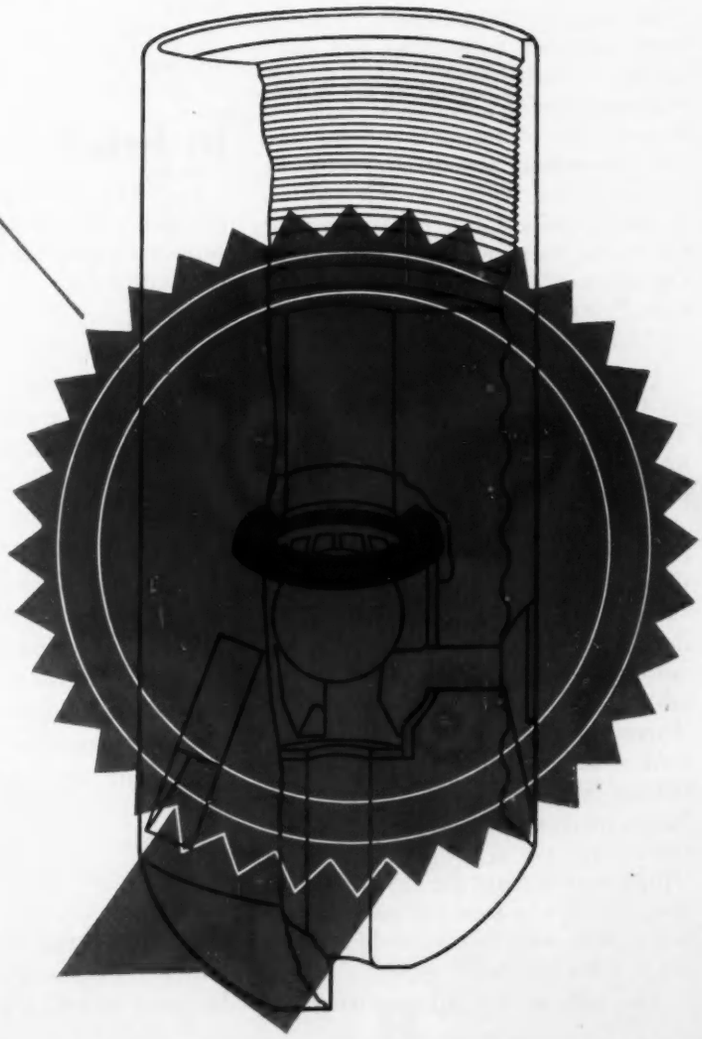

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tive capacity anticipated by a similar study of the Independent Petroleum Association of America.

Discussion in the industry of the not-yet-adopted report centered on oil's financial ability to maintain such a high level of productive capacity, and the possible resultant economic effects such a reserve could have on crude prices. The substantial increase in productive capacity is attributed to numerous reasons, ranging from improved secondary recovery methods to a fast step-up in drilling.

Regardless of the adverse criticism of the reserve productivity problem, the point remains that the industry at the request of the federal government made an all-out effort to build up its productive capacity to a level that can give the nation a margin of safety for any emergency.

Union Asks Another Hike

O. A. (Jack) Knight accepted new union power with one hand last month and with the other beckoned for a second round of pay raises during 1955.

Actually, the initial round of 4 percent increases (10 cents per hour average) had barely begun before Knight asked for a second helping. It was one of his first official acts after becoming president of the Oil, Chemical and Atomic Workers International Union-CIO, formed by the Cleveland merger of his 93,000-man Oil Workers International Union and the 75,000-man United Gas, Coke and Chemical Workers of America.

It would have been to Knight's greater glory had the oil companies held back their pay offers until after he had demanded them as president of the new union.

But the grants were made and accepted prematurely, from his point of view, so he quickly switched tactics. "It is the attitude of the union," he declared, "that what we are actually getting is a wage increase in 1955 which was due to oil workers in 1954. Therefore, there is a strong possibility that within a few months we may launch a new campaign for 1955 wage increases. Lending weight to this threat was that the CIO units which were among the first to accept the company offers did so with the stipulation that they could reopen wage talks again this year.

The independent unions were the first to accept pay hikes. Standard Oil Company (New Jersey) led off with an offer, followed by Humble Oil & Refining Company, Standard Oil Company (Indiana) and Continental Oil Company. Others joined the parade.

First CIO units to agree on pay terms were at Magnolia Petroleum Company, and next was at Gulf Refining Company. The Magnolia local at Wichita Falls was first in line among the production workers.

In brief . . .

Gulf Oil Corporation's first Florida offshore test will be a 12,500-foot project located 7.4 miles southwest of the state's tip.

Standard Oil Company (New Jersey) estimated its consolidated net earnings for 1954 at $584 million, equal to $9.55 a share on the average number of shares outstanding during the year. The Jersey group spent about $754 million last year on capital projects and exploration.

Railroad Commissioners' salaries would be boosted from $10,600 to $20,000 by legislation introduced in the Texas Legislature. The Texas Independent Producers and Royalty Owners Association urged a pay hike along with an increased staff and budget.

An estimate of 2.416 billion barrels of crude and natural gas liquids was placed on Canada's reserves by the Reserves Committee of the Canadian Petroleum Association. Production last year was 97 million barrels.

U. S. Hits It Big Offshore

Tucked away at the tail of a mimeographed government announcement last month were some figures that, with an easy stretch of the imagination, are sufficient to explain why there has been little said in Congress lately about who is going to pay the national debt.

It seems that a respectable chunk of it will be paid by offshore oil activity.

In announcing plans for the federal government's third offshore lease sale, likely to be held in July, the Bureau of Land Management declared that 486,869.86 acres of oil and gas lands and 25,000 acres of sulfur lands were leased off Louisiana and Texas in the first two sales. Bonuses totaled $140,969,005.48.

Thus, the government has received more than $1 in every $5 of the $650 million spent by the industry in operations off Louisiana and Texas, even ignoring taxes and rentals.

The report went on to say that 12 million acres off Louisiana and 8 million acres off Texas have been mapped as potentially leasable. If the acreage already leased is subtracted from this total, there remain 19,488,130 potentially leasable acres. By applying to this figure the same dollar rate paid thus far the government's total take in bonuses alone would be $5,367,031,268.

This is equivalent to more than one-tenth the total investment of the entire oil industry. The statistics to date:

	Texas	Louisiana
Bonus bids, oil and gas	$23,357,929.48	$116,378,476.00
Bonus bids, sulfur	0	$1,233,500.00
Total bonus bids	$23,357,929.48	$117,611,976.00
Rentals received	$201,450.00	$1,234,175.00
Total moneys received	$23,558,479.48	$118,846,151.00
Number of oil, gas leases	19	95
Number of sulfur leases	0	5
Acreage leased for oil and gas	67,148.70	394,721.16
Acreage leased for sulfur	0	25,000.00
Total leased acreage	67,148.70	419,721.16

No Ideal Mobile Barge

Industry is making haste slowly toward the ideal offshore drilling unit.

Though the drawing boards are crammed with the fantastic skeletons of unborn marine monstrosities, most of the bits are still turning beneath platforms augmented by floating tenders. And of the units that are not fixed, but mobile, the most popular is still one of the oldest in design—the fixed deck type with hull support,

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such as Kerr-McGee's aging but nimble Rig 40, its newer and bigger Rig 44, Offshore Drilling and Exploration Company's Mr. Charlie, and others.

Popularity of this type was explained last month by Richard J. Howe of Shell Oil Company, Houston, at the API Southwestern District Division of Production meeting at New Orleans. It results, he said, "from the fact that the fixed-deck design has a general over-all simplicity and is a direct extension of the proven inland drill barge principle."

All told there were eight mobile drilling units in operation February 1, and five of them were of the fixed-deck hull support type. Of the other three, two were of the elevating deck-piling support type employed by Offshore Company, and one was Glassock Tidelands' much-publicized Mr. Gus which is of the elevated deck-piling plus hull support type.

Of the three mobile units building on February 1, one was fixed deck-hull support, another was fixed deck-piling plus hull support, and the third was elevating deck-hull (divided) support.

The variance of opinion as to the most feasible of the existing types of mobile barges can be traced in part to the problems more or less peculiar to each.

Compensation Bill Advances

Two changes were recommended last month during committee consideration of the proposed amendments to the Texas compensation laws introduced in both houses of the Texas Legislature in January by Sen. Searcy Bracewell and Rep. Garth Bates, both of Houston. The legislation introduced would correct abuses in state compensation laws, resulting in more reasonable insurance rates in the oil industry.

Floor consideration of the bills had not been scheduled late in the month.

Committee recommendations for these two amendments were announced:

- Removal of the proposed $2000 limit placed on attorneys fees in compensation cases appealed to the district court. The bills as introduced would make no change in the law allowing attorneys 15 percent of the first $1000 recovered and 10 percent thereafter for representing a claimant before the Industrial Accident Board. However, the proposed legislation asks that if the attorney elects to appeal to the district court, where he now is allowed 33⅓ percent of his client's award, he be limited to 25 percent of the amount recovered or a total fee of $2000, depending on which is the lesser.
- Another committee-suggested changed would raise to $35 a week the present maximum allowance in order to adjust maximum employe benefits upward to conform with present economic conditions. Present maximum allowance is $25 a week, and the proposal was introduced as $30.

Other amendments contained in the bills, and which were approved in committee:

- Proposal to calculate benefits for partial disabilities based on the percentage of maximum benefits, rather than the wage rate.
- Proviso requiring that a compromise or settlement of a compensation claim must specify the weekly rate of benefits allowed and the number of weeks the settlement is intended to cover.
- Protection of employers in cases where an employe aggravates an old injury.
- Provision revising the law on compensation claims arising from travel. New bills propose that the test of a travel case must be the prime purpose for a trip.
- Proposal to bring about long-sought self insurance for financially responsible employers. If the bill becomes law, a company could become a self insuror if it has the free capital and surplus requirements of an insurance company and the same type investments. As an alternative, a financially responsible employer would be permitted to qualify as a self-insuror by furnishing a fund or bond to guarantee compensation payments to his employes.

Hearings Held on Imports

The President's committee statement that excessive imports could damage the domestic economy prompted some large importing companies to announce cuts in their 1955 scheduled imports, limiting their totals to approximately the same as 1954.

In 1954 the major importing companies announced cuts in programmed imports, though for the year as a whole the total reached a new high, averaging 1,063,000 barrels daily.

Release of the committee's report at the end of February, some three months later than promised, came at a time when the debate on imports was at its highest tempo of recent years. The scene has been the hearings before the House Ways and Means Committee and more recently, the Senate Finance Committee, over the Eisenhower Administration requested extension of the Trade Agreements Act. Domestic producers are making their strongest plea for legislation that would establish specific restrictions on imports and have rallied behind an amendment to the trade bill, introduced by Sen. Matthew Neeley, a coal state senator from West Virginia.

This bill would restrict total imports in any quarter to 10 percent of domestic demand in the corresponding quarter of the previous year and would specifically limit residual fuel imports in any quarter to 10 percent of the domestic demand of residual fuel in the like quarter of the preceding year. The bill is co-sponsored by 16 senators from coal and oil states.

Total petroleum imports in 1954 averaged 1,063,000 barrels daily, equivalent to 13.7 percent of the domestic demand (less exports), which amounted to an average of 7,744,000 barrels daily. Residual fuel oil imports averaged 353,449 barrels daily last year, or 24.7 percent of domestic demand for residual. Under the Neeley amendment to the Trade Agreements Act, total imports would have been limited to 774,000 barrels daily, and residual fuel oil imports would have been held to 14,300 barrels daily.

Many domestic producers oppose such limitations on residual fuel oil imports since there is doubt that the necessary supplies of residual could be filled economically without a higher level of residual imports that would be permitted under the Neeley amendment.

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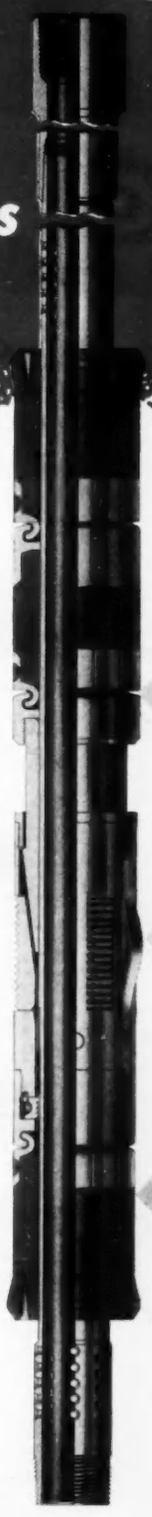

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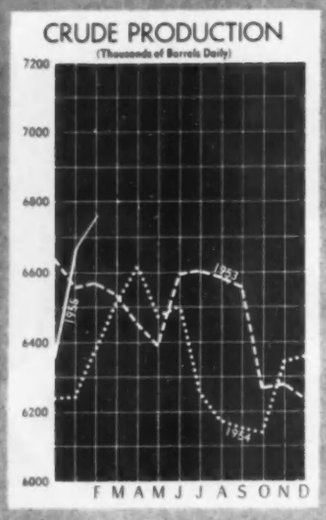
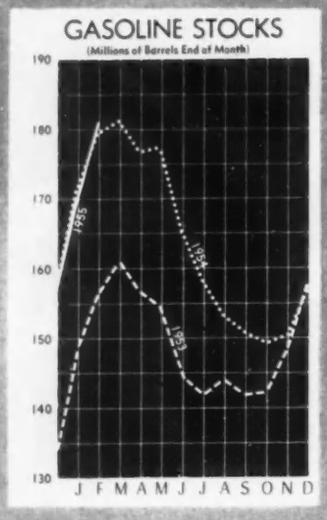
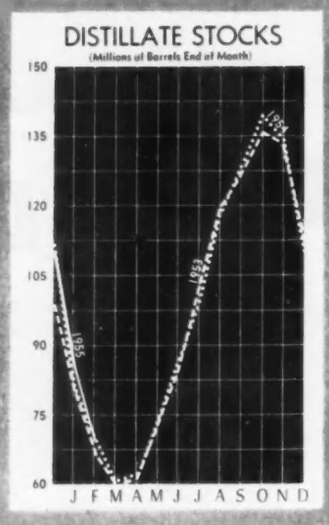
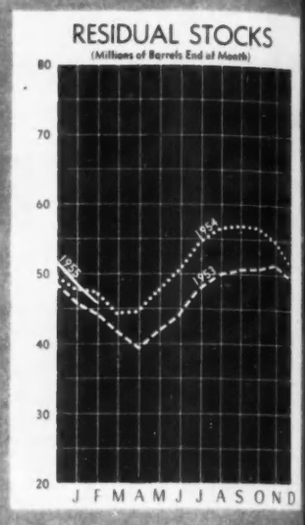
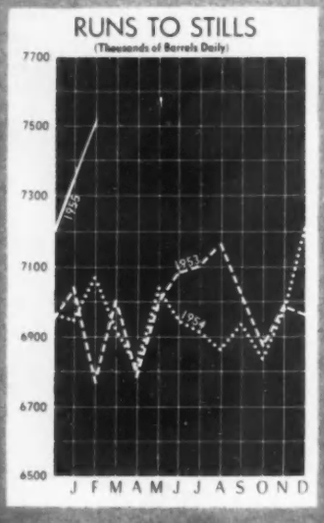
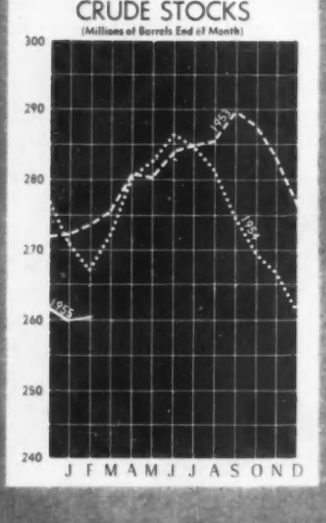












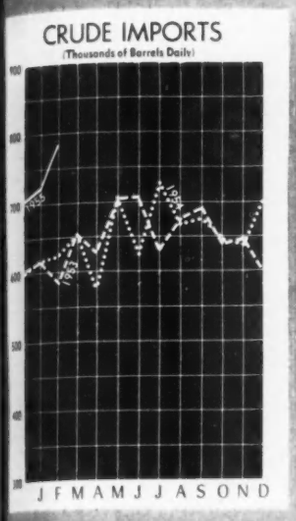
Petroleum Trends in U. S. . . .

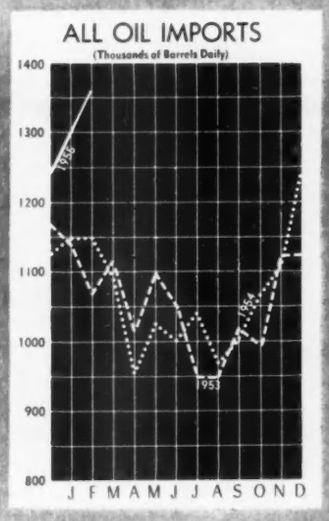
By CECIL W. SMITH, World Oil Staff

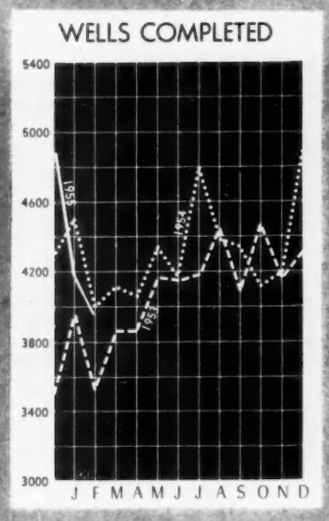
U. S. Crude Production by States

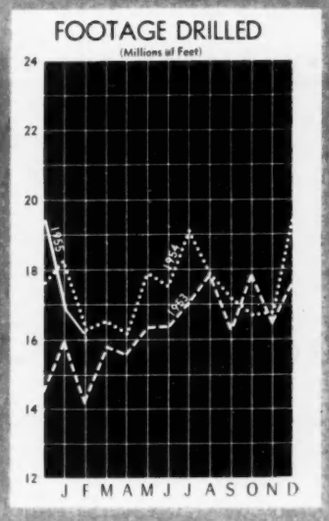
(Thousands of Barrels)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Feb., 1955	Jan., 1955	Feb., 1954	% Diff. Feb., '55-'54	TOTAL PRODUCTION First Two Months 1955	1954	% Diff. '55-'54
Alabama	4.2	4.2	4.7	— 10.6	247	274	— 9.9
Arkansas	74.0	73.4	82.4	— 10.2	4,348	4,743	— 8.3
California	969.8	970.3	997.6	— 2.8	57,234	58,931	— 2.9
Colorado	140.6	141.1	98.8	+ 42.3	8,311	5,505	+ 51.0
Florida	1.4	1.4	1.5	— 6.7	85	90	— 5.6
Illinois	208.2	204.2	176.8	+ 17.8	12,159	10,111	+ 20.3
Indiana	29.4	29.3	33.0	— 10.9	1,732	1,931	— 10.3
Kansas	330.8	325.6	328.6	+ 0.7	19,355	18,636	+ 3.9
Kentucky	40.4	39.4	37.2	+ 8.6	2,355	2,107	+ 11.8
Louisiana	702.0	687.3	693.6	+ 1.2	40,961	41,015	— 0.1
North Louisiana	109.6	106.0	115.6	— 5.2	6,356	6,734	— 5.6
South Louisiana	592.4	581.3	578.0	+ 2.5	34,605	34,281	+ 0.9
Michigan	31.8	33.2	34.4	— 7.6	1,921	1,978	— 2.9
Mississippi	94.8	94.3	94.2	+ 0.6	5,575	5,548	+ 0.5
Missouri	0.2	0.2	0.2		10	9	+ 11.1
Montana	42.7	42.5	35.8	+ 19.3	2,513	1,890	+ 33.0
Nebraska	27.2	25.2	19.8	+ 37.4	1,544	1,135	+ 36.0
Nevada	0.2	0.2	.....	.....	12	.....	.....
New Mexico	219.2	214.3	198.9	+ 10.2	12,778	11,751	+ 8.7
Southeast New Mexico	217.7	212.9	196.8	+ 10.6	12,694	11,621	+ 9.2
Northwest New Mexico	1.5	1.4	2.1	— 28.6	84	130	— 35.4
New York	10.9	10.6	9.2	+ 18.5	636	530	+ 20.0
North Dakota	27.6	28.8	15.0	+ 84.0	1,666	877	+ 90.0
Ohio	10.6	10.6	11.0	— 3.6	624	610	+ 2.3
Oklahoma	556.5	512.1	549.5	+ 1.3	31,456	31,563	— 0.3
Pennsylvania	19.4	19.3	25.3	— 23.3	1,142	1,545	— 26.1
South Dakota	0.1	0.1	0.1	.....	6	2	+200.0
Tennessee	0.1	0.1	.....	.....	2	3	— 33.3
Texas	2,932.1	2,913.8	2,680.1	+ 9.4	172,426	156,308	+ 10.3
Dist. 1—South Central	49.5	46.7	40.4	+ 22.5	2,834	2,368	+ 19.7
Dist. 2—Middle Gulf	157.4	157.4	142.4	+ 10.5	9,288	8,367	+ 11.0
Dist. 3—Upper Gulf	473.6	471.0	438.9	+ 7.9	27,861	25,967	+ 7.3
Dist. 4—Lower Gulf-S.W.	258.2	257.9	245.9	+ 5.0	15,223	14,532	+ 4.8
Dist. 5—East Central	48.6	50.9	38.9	+ 24.9	2,940	2,490	+ 18.1
Dist. 6—Northeast	366.2	369.2	341.3	+ 7.3	21,699	20,352	+ 6.6
Dist. 7-B—North Central	140.4	140.8	125.4	+ 12.0	8,295	7,278	+ 14.0
Dist. 7-C—West Central	187.8	183.9	179.5	+ 4.6	10,959	10,517	+ 4.2
Dist. 8—West	970.6	961.0	847.2	+ 14.6	56,968	49,736	+ 14.5
Dist. 9—North	193.8	189.8	185.6	+ 4.4	11,310	10,926	+ 3.5
Dist. 10—Panhandle	86.0	85.2	80.7	+ 6.6	5,049	4,695	+ 7.5
Utah	6.1	6.0	5.6	+ 8.9	357	301	+ 18.6
Virginia	0.1	0.1	.....	.....	6	1	+500.0
West Virginia	6.2	6.6	8.6	— 27.9	378	506	— 25.3
Wyoming	272.1	271.0	236.8	+ 14.9	16,018	14,156	+ 13.2
Total United States	6,758.7	6,665.2	6,378.7	+ 6.0	395,857	372,056	+ 6.4









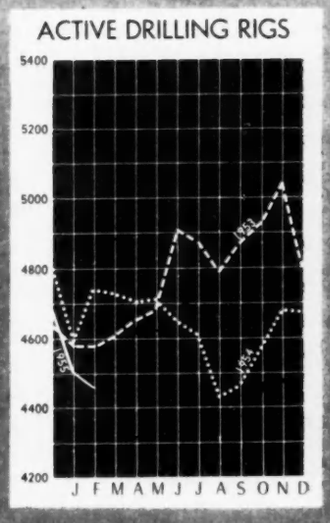
- **Crude output climbs to new high**
- **Peak level hit by oil importers**
- **Refiners reach new high point**

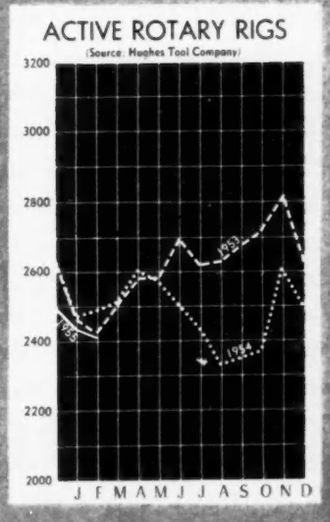
Crude Oil and Refined Products Trends

(Thousands of Barrels)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:											
January..	6,555	7,042	272,250	3,384	150,518	1,528	80,655	1,307	45,910	616	1,135
February.	6,562	6,969	273,589	3,379	157,873	1,505	67,167	1,275	44,178	586	1,066
March....	6,531	7,002	275,665	3,319	162,731	1,489	59,802	1,256	41,600	655	1,112
April....	6,446	6,781	280,487	3,282	158,032	1,424	61,349	1,219	39,572	628	1,010
May.....	6,390	7,002	280,308	3,459	156,415	1,400	73,706	1,197	41,795	703	1,096
June.....	6,595	7,081	283,715	3,467	146,196	1,462	84,504	1,238	43,801	707	1,050
July.....	6,903	7,103	284,976	3,583	143,916	1,441	102,394	1,224	47,966	629	946
August...	6,583	7,163	285,352	3,592	146,050	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	1,448	126,709	1,203	50,516	692	1,013
October..	6,262	6,872	287,541	3,437	144,495	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	1,441	111,944	1,247	49,370	598	1,121
1954:											
January..	6,240	6,947	270,811	3,431	171,704	1,550	81,044	1,271	47,474	617	1,143
February.	6,379	7,068	266,918	3,476	179,950	1,545	70,390	1,241	47,119	621	1,144
March....	6,507	6,923	271,867	3,375	181,297	1,458	60,270	1,168	44,249	654	1,088
April....	6,615	6,811	280,310	3,404	177,006	1,374	61,721	1,140	44,362	574	950
May.....	6,471	7,038	282,250	3,482	177,606	1,372	73,581	1,148	47,009	708	1,021
June.....	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July.....	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October..	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November.	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December.	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January...	6,665	7,343	259,828	3,534	170,349	1,743	86,019	1,218	48,236	720	1,304
February..	6,759	7,501	260,316	3,547	181,753	1,812	67,531	1,245	45,072	789	1,365
Feb., 1955 Change:											
In Month	+94	+158	+488	+13	+11,404	+69	−18,488	+27	−3,164	+69	+61
In Year...	+380	+433	−6,602	+71	+1,803	+267	−2,859	+4	−2,047	+168	+221
Week Ended:											
3-11-55...	6,845	7,476	260,544	3,514	183,424	1,778	63,832	1,219	45,113	675	1,227
3-12-54...	6,458	6,883	263,174	3,262	177,783	1,429	64,895	1,195	45,973	574	923

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Production Cut Is Desirable

AN IMMEDIATE SHARP REDUCTION in U. S. crude production, imports and refining operations is necessary to prevent a general deterioration of the industry's economic position.

Particularly worrisome is the gasoline outlook. Far too much gasoline is being manufactured. Consequently, excessive motor fuel inventories again threaten to plague the industry. Refining operations must be curtailed from their recent peak volumes. This, in turn, will require a reduction in U. S. imports and crude production rates. The quicker such action is taken the smaller the amount of curtailment that will be necessary to correct the situation.

•

GASOLINE OUTPUT MUST BE REDUCED quickly and sharply to avoid building of stocks to burdensome levels during the next several months.

Heavy scale refining operations have rubbed out the improved motor fuel outlook which existed at the beginning of the year. Early March found motor fuel inventories at an all-time peak, although they were below 1954 levels at the start of 1955. They will continue to grow until April, even if output is reduced.

This is the result of too much gasoline being manufactured. So far in 1955 the production of gasoline has been 136,000 barrels per day higher than in the same period of 1954. Consequently, 7 million more barrels of gasoline have been added to storage during the first nine weeks of 1955 than in the corresponding period of the previous year, although additions in 1954 exceeded desirable volumes. Gasoline inventories so far in 1955 have risen by an average of 400,000 barrels daily, in contrast with 280,000 barrels per day in 1954. As a result motor fuel stocks now are nearly 5 million barrels greater than a year ago, although at the beginning of the year they had been 2¾ million barrels less than a year ago.

Record scale refining operations are responsible for the manufacture of too much gasoline. Encouraged by a substantial increase in heating oil demand, U. S. refiners have run far more crude to stills than ever before. Daily average crude runs to stills have been 400,000 barrels per day greater than in the first nine weeks of 1954.

Now that the heavy consuming season for heating oils is over, refiners have no reason not to curtail runs. On the contrary, there is every reason for them to reduce runs so as to make only minimum further additions to gasoline stocks.

•

LESS CRUDE PRODUCTION AND IMPORTS will be needed when refinery runs are curtailed. A reduction of 300,000 barrels per day in U. S. production during April and May appears desirable. Record U. S. crude production and imports so far in 1955 have not caused increased stocks only because of the heavy refining rate. If refinery runs are reduced as expected, current producing and importing rates will cause sharp growth in crude stocks.

U. S. crude production has averaged 6,715,000 barrels daily during the first nine weeks of 1955, an increase of 405,000 barrels over the 1954 rate. March production is expected to average more than 6,800,000 barrels.

Meanwhile, imports of crude and products have averaged 1,336,000 barrels daily in 1955, a gain of nearly 200,000 barrels over 1954. Crude has constituted about 750,000 barrels of the imports.

If crude imports continue at this rate in April and May, U. S. crude production will need to be cut to about 6,500,000 barrels daily to prevent heavy additions to above-ground stocks, a 300,000 barrel reduction from March volumes.

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They can be furnished in either carbon or alloy steel, untreated or heat-treated. The customer receives them nicely rough-machined, so that he can bypass this particular step in his own operations.

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U. S. Wells Completed in February and First Two Months, 1955

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED																Rigs in Operation		
								TOTAL NEW WELLS			Total Footage February, 1955	DETAILS FOR JANUARY-FEBRUARY							
												New Wells			Footage				
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Feb., 1955	Jan., 1955	Feb., 1954		1955	1954	Percent Diff.	1955	1954	Feb. 28, 1955	Jan. 31, 1955	Feb. 28, 1954
Alabama				8				8	6	7	28,827	14	10	+ 40.0	57,148	55,916	6	3	8
Arizona									4	1		4	1	+300.0	16,136	3,630		1	1
Arkansas	19			22				41	42	56	123,910	83	102	— 18.6	289,819	327,157	29	32	32
California	138		4	33				175	164	250	869,152	339	478	— 29.1	1,681,826	2,193,074	265	241	238
Colorado	29		3	75				107	109	75	579,556	216	172	+ 25.6	1,153,737	960,054	70	72	85
Florida				3				3	6	4	16,721	9	8	+ 12.5	60,237	49,586	3	2	2
Georgia													1	—100.0		4,264			3
Idaho				1				1			4,530	1			4,530				
Illinois	128		1	110	1			240	303	172	576,533	543	492	+ 10.4	1,327,142	1,238,845	242	277	217
Indiana	13			23				36	44	49	59,158	80	140	— 42.9	128,028	201,893	94	97	111
Kansas	188		26	129				343	322	311	1,262,756	665	637	+ 4.4	2,435,805	2,208,943	470	460	440
Kentucky	58		16	51				125	107	102	205,829	232	210	+ 10.5	383,568	401,405	78	94	85
Louisiana	184	19	8	82				293	351	234	1,738,646	644	530	+ 21.5	3,812,105	3,543,994	315	309	243
North Louisiana	119	5	3	31				158	198	115	421,113	356	256	+ 39.1	991,754	784,432	69	59	55
South Louisiana	65	14	5	51				135	153	119	1,317,533	288	274	+ 5.1	2,820,351	2,759,562	246	250	188
Maryland																	2	3	3
Michigan	11		1	29				41	56	43	125,330	97	104	— 6.7	288,421	261,970	68	76	94
Mississippi	18	2		26				46	31	30	372,754	77	51	+ 51.0	603,962	338,168	46	45	29
Missouri				3				3	5	1	2,159	8	4	+100.0	5,494	4,533	2	2	1
Montana	9			23				32	28	23	158,034	60	87	— 31.0	294,891	322,076	31	39	25
Nebraska	17			36				53	43	31	302,161	96	68	+ 41.2	536,738	380,297	40	32	21
Nevada				2				2	1		12,233	3			22,416		2	3	3
New Mexico	67		24	11				102	91	104	472,589	193	218	— 11.5	854,760	1,201,234	132	120	129
New York	15				10			25	26	58	34,629	51	130	— 60.8	70,861	181,188	40	41	94
North Dakota	11			2				13	16	19	92,408	29	40	— 27.5	211,072	245,600	23	24	32
Ohio	33		14	22				69	90	67	141,924	159	135	+ 17.8	342,055	273,862	195	201	193
Oklahoma	277	6	10	121	1		3	418	553	686	1,509,879	971	1,372	— 29.2	3,437,338	4,745,912	638	665	729
Oregon																	1	1	
Pennsylvania	18		14	5	16	5		58	58	114	110,997	116	218	— 46.8	214,948	368,860	104	116	255
South Dakota									2	2		2	4	— 50.0	6,752	13,029	2	2	2
Texas	882	30	48	619	13		1	1,593	1,563	1,382	6,880,204	3,156	2,938	+ 7.4	13,672,656	13,480,183	1,313	1,286	1,348
Dist. 1: South Central	78	3		48				129	137	87	389,591	266	156	+ 70.5	727,509	512,957	52	53	33
Dist. 2: Middle Gulf	25	7	9	26				67	63	75	396,497	130	161	— 19.3	791,818	970,020	29	32	37
Dist. 3: Upper Gulf	67	3	6	57				133	143	134	854,035	276	268	+ 3.0	1,782,708	1,849,451	116	117	118
Dist. 4: Lower Gulf-S.W.	35	7	8	65				115	112	118	606,074	227	252	— 9.9	1,234,490	1,328,048	70	73	83
Dist. 5: East Central	7			20				27	24	10	107,111	51	25	+104.0	224,200	100,280	14	13	14
Dist. 6: Northeast	25	5	2	25				57	43	56	317,038	100	104	— 3.9	562,406	660,658	61	51	73
Dist. 7-B: North Central	122		4	123				249	268	240	717,827	517	504	+ 2.6	1,538,980	1,647,094	148	140	150
Dist. 7-C: West Central	69	2	3	25				99	108	99	565,713	207	241	— 14.1	1,125,030	1,144,265	135	134	148
Dist. 8: West	208	2		58	2			270	278	172	1,489,338	548	434	+ 26.3	3,013,911	2,698,421	380	369	358
Dist. 9: North	185		4	164	11		1	365	301	311	1,159,474	666	619	+ 7.6	2,108,659	1,998,358	233	236	245
Dist. 10: Panhandle	61	1	12	8				82	86	80	277,506	168	174	— 3.5	562,945	570,631	75	68	89
Utah	1		2	8				11	9	4	63,849	20	8	+150.0	105,880	52,222	14	16	17
West Virginia	8		23	10				41	63	30	114,770	104	67	+ 55.2	281,324	190,421	175	170	183
Wyoming	44		2	20				66	69	139	335,693	135	263	— 48.7	707,120	1,305,832	56	72	120
Total United States	2,168	57	196	1,474	41	5	4	3,945	4,162	3,994	16,195,231	8,107	8,488	— 4.5	33,006,769	34,554,148	4,456	4,502	4,743
Total Western Canada	197		9	51			2	259	183	129	1,175,076	442	298	+ 48.3	1,923,107	1,243,856	199	194	155

Completions Decline

But two-months' total nearer 1954 pace.

COMPLETED WELLS took their customary dip during February. As usual, the number of wells drilled did not equal the previous month's due to the shortness of the period, and bad weather in many areas.

February's completed wells totaled slightly fewer than those recorded in the same period of 1954, but they narrowed the difference between the two years' operations. At the end of January, this year's wells had trailed 1954's by 7.4 percent, while at the end of February this margin had been reduced to 4.5 percent. This span is expected to continue to narrow in the coming months, with the final outcome to be a new drilling record for 1955.

At the end of two months' drilling, new wells totaled 8107 in the U. S. That was 381 wells or 4.5 percent less than the 8488 recorded through February of peak 1954. February's completions were 49 fewer than last year's same month's, but January had shown a deficit of 332 from its comparable period.

A bit unusual was the fact that the amount of footage drilled in this year's wells was off from last year's footage by exactly the same percentage as were the wells. In year's past, the trend had been toward deeper drilling, with each well deeper on the average. However, so far this year average depth was 4071 feet, which was exactly the same average as last year's tests. An aggregate of 33,006,769 feet of hole were represented in this year's wells, and a year earlier the accumulated total was 34,554,148 feet.

Only one of the top five drilling states lowered its drilling activity from a year before. That one was Oklahoma where new wells numbered 971 against 1372 a year ago, for a decline of 29 percent. Oklahoma, however, still remained the second most active drilling state in the nation.

A hike of 7.4 percent in operations resulted in 3156 new wells in Texas, while the same period of 1954 had produced 2938. Kansas, increased its operations to 665 new wells, which was a gain of 4.4 percent from last year's 637.

Louisiana held onto fourth spot with 644 wells, a gain of 21.5 percent from a year ago. Firmly in fifth place was Illinois with a 10.4 percent increase to 543 wells from 492.

JEEP-MOUNTED high resolution reflection system is operating in a mountainous area of western U. S. The inset illustrates, left to right, the blaster, seis cable on portable reel, amplifiers and camera.

Geophysical Instrumentation Is Making Rapid Progress

Significant new techniques include magnetic recording, mechanical plotter, weight dropping for seismograph shock, single-ship method of marine shooting, and the expansion of frequency range in seismograph recordings.

By F. J. AGNICH, Executive Vice President, Geophysical Service, Inc., Dallas

AS AN APPLIED science, geophysics has scarcely attained voting age. But development of the tools of the science—geophysical instruments—has progressed at an increasingly rapid pace.

"Recent developments" in geophysical instrumentation is a subject more suited to a lengthy book rather than an article. At the present rate of development even such a book would be outdated in many respects by the time it came off the press.

Actually the term "recent modifications" might more accurately describe some of the developments that have evolved in the past few years. In much the same way that the automobile engine of today resembles the one in the first Model T, so do the geophysical instruments of today resemble those first used. They are still electronic devices, but they have been greatly modified to provide a much greater range of usefulness to the exploration geophysicist.

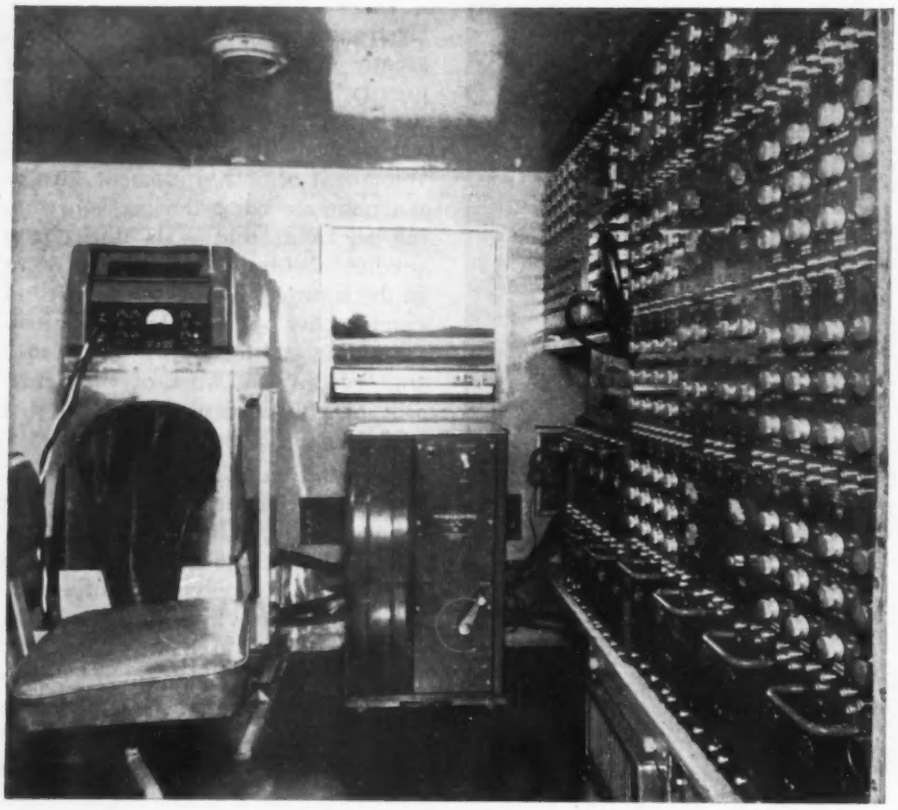
However, the progress in actual development of new equipment such as magnetic recording devices, is becoming so rapid that it is difficult to predict accurately what may occur in the future. It is safe to assume that coming developments, both in instrumentation and technique, will be such that geophysical work of the future will bear little resemblance to that which has been done to date.

Take a quick look at what has occurred to the science in the past quarter-century. In reaching the current era of technological development the science of geophysics has followed the general growth pattern normally followed by any science. That is to say, no appreciable progress was made until a commercial application of the science was formulated. In geophysics, this occurred in the early 1920's.

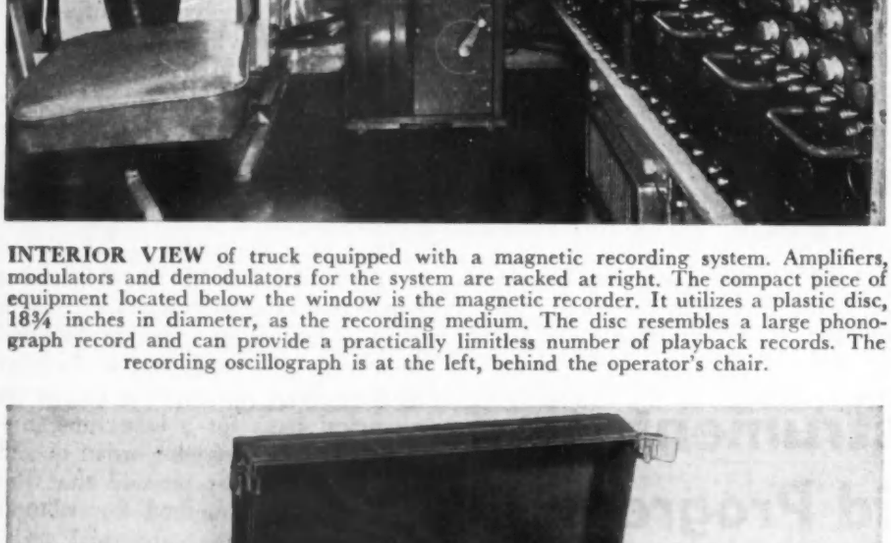
With the application of the science to a profitable field, there began a rapid rise of activity, followed by a plateau insofar as scientific development was concerned. The application of the science was more or less on an empirical basis for a long time. Experimentation was the order of the day. And it must be said that the trial-and-error method contributed much to current geophysical techniques.

The techniques used in pattern shooting and spread length variations are largely the results of experiments carried out in attempts to improve record quality in geologically complex areas. It has only been in the last 5 to 10 years that widespread geophysical research programs began to get underway in earnest.

Magnetic recording equipment that now allows the geophysicist to collect and store geophysical data in a scientific manner is one of the most important results of this intensive research. The playback feature of magnetic recording will greatly change the picture in a number of recording situations. By using magnetic equipment it is possible to shoot the area in question broad band to obtain a record with a great number of significant events. Later this record can be played back with the desired filterings, thus giving the effect of "reshooting"



INTERIOR VIEW of truck equipped with a magnetic recording system. Amplifiers, modulators and demodulators for the system are racked at right. The compact piece of equipment located below the window is the magnetic recorder. It utilizes a plastic disc, 18¾ inches in diameter, as the recording medium. The disc resembles a large phonograph record and can provide a practically limitless number of playback records. The recording oscillograph is at the left, behind the operator's chair.



VERY LOW FREQUENCY refraction system used to record VLF seismogram. It features a one-cycle, linear amplifier and a special two-cycle seismometer, shown in the foreground.

All illustrations courtesy Geophysical Service Inc.

the area with various filter settings.

Magnetic recording equipment will have considerable impact on the geophysical industry in the coming years. Much of the seismic equipment currently in use can be used in conjunction with magnetic recorders after only slight modification. But certainly the future will see new equipment . . . amplifiers, cameras and utility equipment . . . designed and built specifically for use with magnetic recorders. However, at the present time, the industry may not be quite ready to accept, or even able to accept, magnetic recording on a large scale. Current interpretation techniques will have to be revised drastically in order to allow magnetic recording its fullest application. This is being worked out in the research laboratories in the form of the long-sought electronic computing and correlation equipment.

Magnetic recording techniques and interpretation will require a much more scientific approach than is currently in use with conventional equipment. The trend will be to the establishing of a greater number of central computing offices staffed with electronic brains and Ph.D's.

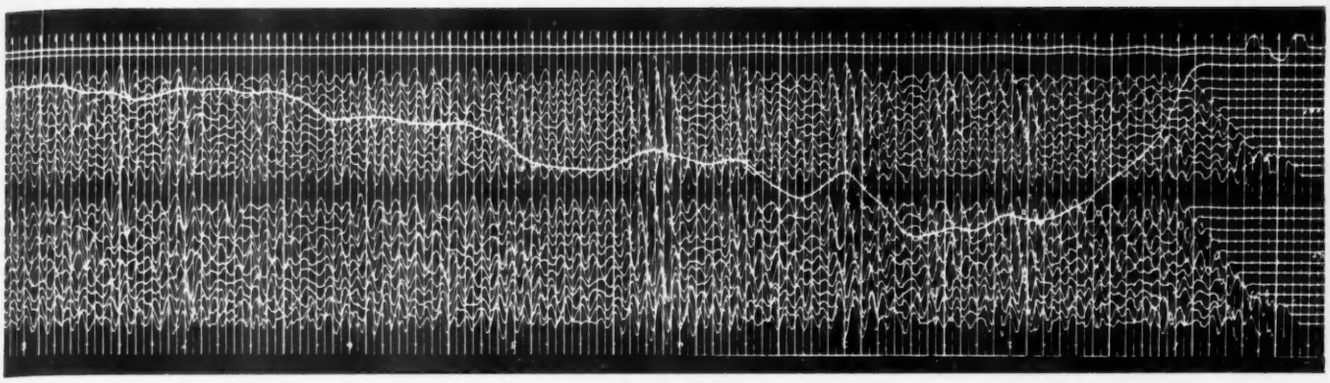
It has been pointed out that if current seismograph systems have N variables then the addition of magnetic recording will confront the operator with N^2 variables.

This is analogous to the fellow who is perfectly capable of taking a creditable picture with his old box camera, but falls flat on his photographic face when he tries to use a Leica.

The fact that magnetic equipment and automatic computing equipment will allow us to collect and process data many times faster than we do at present does not mean that the industry will be staffed with persons of low technical ability who serve only to adjust dials and mail in completed survey reports. On the contrary, as has been said before, the trend will be toward the use of technical people with advanced degrees.

As always the human element is the factor that swings the scales toward excellence or mediocrity, and with the advent of more complicated equipment the human element will become an even more important factor than it has been in the past.

Other advances. In the field of interpretation one of the newer developments is an electromechanical plotter that basically speeds processing of



THIS SEISMOGRAM was recorded with a recently developed high resolution reflection system. A 90-210 filter was used to obtain the desired reflections of 100 cycles per second. The additional trace is made by the Log Level Indicator. It indicates relative energy values, the peaks in the LLI trace being related to the reflected events.

records by transferring the raw data —corrected for weathering, stepout, elevation or water depth—onto a cross-section.

It also gives the geologist with a limited geophysical background a chance to better check on the geophysicists' interpretation.

One step made in the past few years is the development of equipment and techniques that measure the energy detected by the individual seismometers, thereby giving a check on trace unrest due to seismic noise. The equipment is a self-calibrating voltmeter designed to measure the energy received by the seismometers before amplification, or the amount of energy recorded after all amplification and filtering and just prior to being fed into the camera.

The equipment may be incorporated into any currently available seismic system and in pattern shooting can obtain an absolute measure of the voltage output of each seis group and thus ascertain the effectiveness of the pattern—a far cry from the days when the seises were laid out partly by guesswork.

Experimentation in a new vein, that shows promise toward finding other types of generated energy which can be applied to obtaining seismic records, has taken the form of a weight-dropping device that provides the shock which initiates the signals recorded by the seismometers.

This device incorporates metal weights, dropped from a platform carried on the rear of a truck. The weights, rather than dynamite, serve as the initial energy source. The equipment eliminates the need for drilling shot holes, but necessitates the taking of a large number of recordings in a single area.

Marine exploration has taken a big jump in the days since the end of World War II, and advances made in offshore instrumentation are still another facet of the over-all "developments" picture.

As the tidelands problem was resolved and geophysicists began moving farther out to sea, it became evident that conventional equipment and techniques used in land exploration would have to be revised to meet the problems encountered in marine work.

Here again, however, the revisions have taken on more the color of modifications rather than direct new developments. We have graduated from the shoreline-hugging school where the surveyor based all his calculations on some plainly visible landmark; but in general we still use the same amplifiers and the same seismometers we have used in land exploration—with important modifications.

In marine exploration, the single-ship operation may be called the most successful of recent developments. Ships larger than the vessels of the conventional seismic fleet can be equipped for this operation to proceed under their own power to undertake extended marine work in any section of the world. In essence, the single-ship method is a means of continuous operation which allows shooting and recording to proceed without the necessity of stopping the recording vessel for each shot. Under proper program conditions, great speed can be attained with this method.

Among developments making possible the single-ship method should be listed the streamer type of detector array. Both pressure-sensitive and velocity seismometers are available today in smooth-jacketed streamers which are especially designed for this high-speed offshore work. Magnetic recording is being used successfully in the single-ship operation, and rapidity and ease of handling of the system employed contributes to the

Continued on Page 114

About the Author

F. J. AGNICH, executive vice-president, Geophysical Service, Inc., was born at Evelath, Minn., and was graduated in 1937 from the University of Minnesota with a B.A. degree in geology. His first job was as junior engineer with the Minnesota Division of State Parks. In 1937 he joined Geophysical Service, Inc., as helper-permit man. Later he worked as computer in the U. S., Venezuela, and Sumatra from 1937 to 1943, when he was appointed party chief. He was appointed supervisor in 1947 serving in Texas and the Rocky Mountain area until 1951 when he was named to his present position. He is a member of the AAPG, SEG, Dallas Geological Society, Dallas Geophysical Society, American Management Association and Minnesota Alumni Association.

Photo Courtesy U. S. Geological Survey

COLLECTING FOSSILS from Upper Cretaceous beds in McKinley County, New Mexico. Group is composed of geologists, a paleontologist and a paleobotanist.

Geologists Are 'Working Those Hills'

There is still lots of surface work to be done in the search for oil.

By FRANK GOUIN, Independent Geologist, Duncan, Okla.

TO MAKE A SUCCESS of his profession, the petroleum geologist must "work those hills." Only by working the hills, the valleys, and every out-of-the-way spot, can he hope to achieve the goal for which he has been trained—to find oil!

The petroleum geologist is a relatively recent specialist in the general field of geology. Half a century ago he was looked upon with suspicion and a certain degree of toleration. It took a generation for him to become recognized and established and win his spurs. The oldtime petroleum geologist did this the hard way. In his time there were few of the modern conveniences which today's geologist takes as a matter of course. There were no paved highways and few "steam buggies." He relied on horse and pack saddle. But, most of all, he relied on his two stout legs, and a pair of sharp eyes to, first, reach the spot to be studied, and next, to study and evaluate.

Noteworthy among the pioneers who demonstrated the importance of field work were the oldtime geologists with the U. S. Geological Survey. More than a century ago, Geologist S. F. Peckham walked the hills of Kentucky and left a record of his findings, reporting, among other interesting matters, the "hard luck" of some salt diggers near Birksville in Cumberland County, who drilled a well for salt and had to abandon it because the well flowed such a large amount of oil that it had to be plugged.

The old annual reports of the Geological Survey tell of the work of the old foot-slogging geologist. The first mention of oil and gas in these reports is contained in Part II of the Eighth Annual Report for the year 1886-87. The author, Edward Orton, gives an account of the discovery of the Lima-Indiana field in 1884 by reason of locating the discovery well close to an oil seep in a limestone quarry. Other notable authors in the series are Arthur John Phinney, F. H. Oliphant and George H. Eldridge. These geologists were specialists on surface criteria for prospecting for petroleum and natural gas. These, and other geologists, roamed over Pennsylvania, New York, Kentucky, West Virginia and then followed the signs—"worked the hills" westward—towards Ohio, Indiana, Illinois, Kansas, Oklahoma, Louisiana, Wyoming, Colorado, Texas and finally to California.

Reading the record of those early pioneers who "worked those hills," we find they all had their individual methods to fit the circumstances and the localities in which they were working. After satisfying themselves that the area in which they were working had evidences of the presence of petroleum they used all surface information possible to determine the most favorable spots.

J. Y. Snyder of Shreveport, La., used soil maps to supplement his field data while mapping the Homer and Haynesville prospects, which were developed later into major oil fields. Those two folds (Homer and Haynesville) were quite obscure before oil field roads cut across them.

Noah Adams, Max Bauer, Carl D. Smith, A. E. Fath, Charles T. Kirk were other well-known geologists whose extensive and careful surface work paid off in eastern Oklahoma. In southern Oklahoma the work of Taff, Gould, Robinson, Kennedy, Larkin, Griswold, Becker, Birk, Tomlinson and others resulted in the discovery of many important oil fields. More recently, Frederick F. Mellen showed what can be done in mapping the area which resulted in the discovery in 1939 of the Tinsley, Miss., field.

All of these and many others had sensible reasons for choosing the areas in which to do their work and then used every available bit of evidence in that area. Discoveries are still being made as a result of their surface work.

Now the trend seems to be in the right direction. Back to the basic principles of geology in which the newer geological tools are being called in to supplement, rather than to supplant the original tools and methods of the successful pioneer petroleum geologists.

Sidney Powers was one of the great masters in the most efficient use of all geological tools. He was responsible for introducing the reflection seismograph into the Mid-Continent, and first used it in the Seminole area to check anomalies he had mapped by other geological methods, but which required further confirmation. The success of this program was outstanding. Unfortunately, there were some who attributed this success to the use of the seismograph alone, and some even hailed it as a new oil finding method in which geology had no role. After the expenditures of millions of dollars by prospectors who employed only physicists and mathematicians to shoot huge areas in blanket fashion with mediocre results, the pendulum swung again in the opposite direction.

About the Author

FRANK GOUIN was born in Winnipeg, Canada, and received his B.A. degree in geology from the University of New Mexico at Albuquerque in 1916. Upon graduation he went to work for the Empire Gas & Fuel Company in Oklahoma. After service with the U. S. Army in World War I he joined Atlantic Oil Producing Company as district geologist in southern Oklahoma and later was promoted to division geologist for Oklahoma and Kansas. He resigned from the company in 1925 and since then has been engaged as an independent geologist and oil producer with headquarters at Duncan, Okla.

Fortunately for the industry, it is now pretty well agreed that oil finding is a geological problem, regardless of the tools used in solving that problem. Geophysical companies today are much keener and cooperative when called in to help solve a structural problem in an area where the geologist already has "walked those hills" and has a notebook of favorable data and/or ideas. When well planned beforehand, the checking can often be done with a minimum expenditure of time and money.

In the field. It is refreshing these days to see geologists busy in the field—with the younger geologists as assistants. They are not only mapping the areal geology and structure, but also observing oil and gas seeps, bituminous sandstones, unconformities, tension cracks, faults, fractures, thrusts, presence or absence of metamorphism, and all the innumerable criteria which are so essential to proper evaluation of any area with respect to its oil and gas possibilities, and for which there is no satisfactory substitute other than actually seeing on the ground.

The same trend is noticeable in the drilling and completion of wells. Here the experienced geologist is again back at the well site on the job and can use his experience in evaluating cuttings fresh out of the hole, the nature of any odors, rainbows in the wash water and all of the many criteria which are lost when the sample is cooked, dried and transported from the well site to an office. The experienced geologist knows the sort of evidence which is of value as compared to that which is commonplace.

In this latter-day revival of the use of surface geologic mapping in oil finding, two great truths are becoming more apparent. One is in overlooking the obvious when it comes to evaluating the possibilities of any area or region. The other is that often the structure appears too obvious and therefore a waste of time to map it in detail.

Examples are not needed as illustrations for those who have been practicing petroleum geology for any length of time. However, one or two examples of the fallacy may be apropos. It is well known that early settlers in Canada knew of the existence of oil and gas seeps in Alberta and recognized them as indications of underground reservoirs of oil and gas. Turner Valley was discovered, but this success was not sufficient to justify all the seeps, and geologists such as Ted Link, Ed Hunt and others were far from satisfied. By steady application to the problem, those who sought for the answers were rewarded in the knowledge afforded them by the sensational oil discoveries at Leduc, Redwater and in other parts of the great plains area of Alberta. The discovery of the Cuyama Valley area in California and the Madill area in Southern Oklahoma are other outstanding examples.

The second fallacy is not taking time for detailed mapping when the fold seems so obvious. The literature is replete with examples of areas condemned by the drilling of dry holes

where it was later proved the locations were poorly spotted due to a lack of adequate mapping. The story of the expensive deep test in Wyoming which drilled through a thrust at a depth of several thousand feet, thus putting it into beds younger than those encountered at the top of the hole, is by no means apochryphal. Unfortunately, the Rocky Mountain area offers many such examples. Probably because reconnaissance of the huge folds suggests that more detailed mapping is a waste of time. Southern Oklahoma has its share of such follies. Many of the failures could have been avoided if more geology had been practiced in the field and less in a swivel chair.

Aerial photography has become an important step in the work of mapping the earth's surface. The technique is improving rapidly. While much can be done from interpretative results of aerial photographs, it stands to reason that more information can be secured by working with such photographs in the field instead of in an office.

It would appear that the search for uranium sources during the past ten years has had an important bearing on the revival of surface geologic mapping. This strategic mineral is scarcely ever found along the paved highway. The geologist has to "work those hills" to find it. This search for uranium is having a most beneficial influence on the petroleum geologist. Many are finding it much more stimulating to hit the trail with pick and Brunton than to stay in town poring over maps and countour lines. The industry, generally, may not realize it, but new hydrocarbon deposits have been found which are attributable directly to the work of the surface man.

Geological and geophysical tools are improving every day and increasing the percentage of success in oil finding. But there are serious and important factors which demand that the cost of oil finding be cut to the bone. This calls for the most intelligent approach to the location of wildcat and extension wells. Geologists should make the utmost use of every tool at hand. But they must not forget the natural power of locomotion. Wherever possible, they should continue to "work those hills"!

—The End

Geophysical Instrumentation

Continued from Page 111

high production rate obtained by the operation.

Broad band magnetic recording has its own special advantage in water work, since the "reshooting" effect obtainable by repeated playbacks eliminates the difficulties of pinpointing and returning to a marine shotpoint should additional records be required.

Frequency range expanded. One of the most important developments has recently come to light with the announcement that newly designed seismograph systems have tremendously expanded the frequency range in which useful seismic information can be recorded.

Until the development of the new systems the geophysicist was fairly well confined to working with data obtained in the frequency range of approximately 18 to 70 cycles per second. But with this new battery of seismic tools, the range has been extended to where it is possible to obtain clear and workable recordings in a frequency range from 2 to 500 cycles per second.

Several distinct systems are concerned in the expansion of this seismic range.

For the recording of very low frequency energy one instrument manufacturer has on the market a new refraction system capable of recording in the 2 to 50 cycles per second frequency range.

The refraction seismograph was, of course, the first seismic system used in oil exploration. Early models were modifications of earthquake seismographs. The big drawbacks to the early systems were their cumbersomeness and inability to record low frequencies and build up a satisfactory signal-to-noise ratio. However, a great many salt domes in the Gulf Coast and East Texas areas were located with the early refraction method.

Many of the limitations and deficiencies apparent in this early equipment have been eliminated in the new refraction tools. The new very low frequency system is quite portable; the 12-channel amplifier weighs only 35 pounds, and the 2-cycle seismometers weigh about 17 pounds each. The greater sensitivity of the new refraction system permits the use of much smaller powder charges than were used in early refraction work. Clear definition of first breaks, gained with the new equipment, greatly increases the accuracy and resolution of the refraction method.

A reflection system that incorporates transistors in its AGC circuit has recently been announced. This is a step by one manufacturer toward utilizing more of these electronic mighty mites in the construction of seismograph instruments. The adaptation of transistors to the seismic amplifier system would add much to reducing the size of existing systems, thereby increasing their portability and incidentally reducing the amount of power needed to operate the system. It appears that current transistors are too noisy to be used in amplifier systems, but that problem will be solved in the future.

The development of a high resolution reflection system, with a frequency range from 30 to 500 cycles per second, has proven a bit further that the seismic technique can profitably be applied to industries other than the oil industry.

This versatile system has seen wide application in the oil industry and there has been a considerable amount of interest shown in the results obtainable with the equipment in the mapping of shallow horizons. It shows great promise for application to stratigraphic problems. The equipment has been used in prospecting for uranium and in other mining ventures. Since, in many cases, the system can successfully locate sedimentary structures which control mineralization—buried river channels, dikes, seams and other similar features—it will see further service in phases of mining. In iron ore mining by the strip method, for example, the high resolution system may be used to determine depth of overburden. Other applications are found in civil engineering problems and in ground water location.

The period of greatest development in the science of geophysics lies still in the future. Research is a lengthy process, and in geophysics, extensive research has not been under way long enough to bear a great amount of really new fruit. But the modifications made in the past few years, both in equipment and technique, are all part of the developments picture and clearly point the way to a new technological era in geophysical exploration.

—The End

Confidence

Here are some pictures of a General crew on one of our recent programs. This job was over land and water, too. You just can't beat General's background in all phases of geophysical exploration. In addition to unsurpassed accuracy and dependability, those people at General actually become a part of our organization when they work for us. I'm in favor of using them again for our next exploration project. We **know** they will do the job for us—right.

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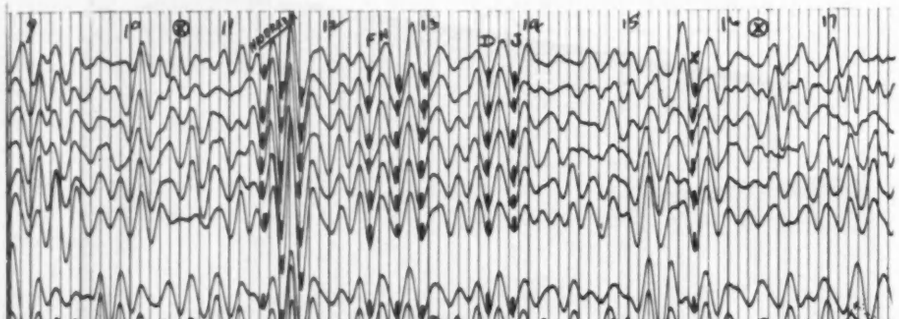

Fig. 1—Portion of a correlation type seismic record taken with 32-62 filter in Adams County, Colorado.

New Techniques Being Used To Find Stratigraphic Traps

Progress is being made with both seismograph and gravity meter. But the problem is difficult. Suitable tools and methods must be used.

By NEAL CLAYTON, Liberty Exploration Company, Tulsa and
RICHARD A. POHLY, Pohly Exploration Company, Tulsa

ONE OF THE MOST difficult problems the geophysicist has been called upon to solve is the location of stratigraphic traps. That the problem is an important one can be proven easily. Mention need only be made of a few of the important producing areas to do this: West Edmond in Oklahoma, East Texas, Adena in the Denver-Julesburg Basin, Mush Creek, Fiddler Creek and Osage of the Powder River Basin, and the Golden Trend in Garvin County, Oklahoma. In all of these major producing areas the oil accumulation is believed to be due to a stratigraphic trap. The Denver-Julesburg problem is a very real one to those who have done seismic work there. Recently, the discovery of Red River production on the east flank of the Baker-Glendive anticline has stepped up activity in that section. The accumulation here is believed to be stratigraphic in nature.

Many different methods have been tried in attempts to predict stratigraphic accumulation in advance of the drill. Hill, in his paper on the Golden Trend of Oklahoma, describes a successful seismic program which predicted where Springer beds would be truncated by lower Deese on the flank of the Pauls Valley uplift.[1] A few years ago, Thralls described a means whereby isotime maps could be used to follow a shoestring sand in Oklahoma.[2] It is not within the scope of this article to describe the many different techniques in detail or to pass on each one's advantages or disadvantages. The various geophysical means used in locating stratigraphic traps may be grouped as follows:

- Seismic methods.
- Gravimetric methods.
- Magnetic methods.
- Resistivity methods.
- Radioactivity methods.

Only the first two of the above groups will be discussed here. Since more exploration dollars are generally spent each year for seismic work, recent improvements in this method will be discussed first.

Two recent improvements in the seismic technique should prove to be helpful in locating stratigraphic traps. These are the magnetic tape recorder and the high resolution reflection seismograph. Actually, both of these techniques were developed primarily for other purposes. In the case of the tape recorder, the primary purpose was better results in "poor record areas." The high resolution seismograph was developed primarily to secure very shallow events.

The geophysicist's problem in the Denver-Julesburg basin is a very interesting one. Here the largest and most productive field, Adena, is caused by the shaling out up dip of the "D" and "J" sands of the Cretaceous. If the seismograph is to be successful in this basin, a way must be found to predict the relative thickness of these sands. At least one company has claimed some success in doing this by the use of isotime maps that include one or both of these Cretaceous sands. In order to solve this problem the following conditions must be met:

- Exact identification of all seismic events between the Fort Hayes limestone and the Morrison formation on each record.
- Sufficient resolution to be able to measure accurately several time intervals in this portion of the geologic section.

A scarcity of well velocity information could well prevent the fulfillment of condition one, while a lack of "clean" records would do the same thing for condition two.

Figure 1, is a portion of a seismic record taken in Adams County, Colorado, using a 32-62 cycle filter. The label D-J is not to be taken as representing actual reflections from the

sand members, but as the approximate position of this zone on the seismic record. The authors believe that greater resolution of this zone may eventually allow the seismologist to follow the relative thickness of these sands. During a recent survey in Adams County, Colorado, several high frequency recordings were made. These indicated that a considerable amount of resolution is possible for the D-J zone, even with conventional filters. A discussion of the use of the magnetic tape recorder will not be included in this paper. There have been several excellent articles written about this instrument. A combination of the tape recorder and the HR seismograph may be required for a solution of the Denver-Julesburg problem.

The basic theory utilized in the preparation of isotime maps for the Denver-Julesburg Basin is that a difference exists between the interval velocity through a sand member as compared to a shale member. The sand velocity is believed to be somewhat lower. Thus, an isotime map prepared for an interval which includes the "D" and "J" sands should indicate a greater time where more sand is present. Severe filtering, such that random noise is largely eliminated, may be required in order to make the preparation of such "time" maps practical. The idea is yet to be thoroughly tested on a regional scale with the drill. Results obtained thus far indicate that progress is being made in solving the problem.

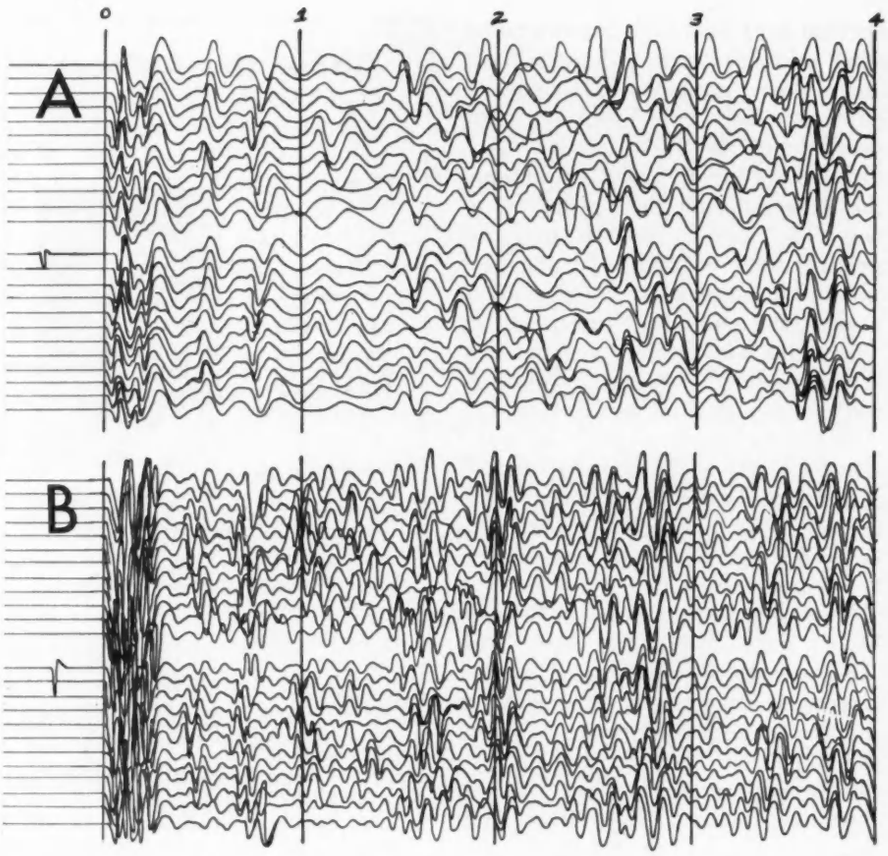

Fig. 2—Record A taken in Gulf Coast with conventional filters; Record B was taken with 90-cycle minimum on high-pass band.
Courtesy Houston Technical Laboratories

An example of the greater degree of resolution possible with the HR instruments is illustrated by Figure 2. While this particular record comparison was made in the Gulf Coast, similar clarification can be expected in other areas. Theoretically, smaller lithologic changes should be "seen" the higher the frequency or the smaller the wave length used. This is the principle behind the HR system which should make it invaluable for stratigraphic studies. What the geologist needs most is help in following litho-facies changes either locally or regionally by geophysical methods. It is believed that reflections may actually be recorded from both the top and bottom of very thin members in a geologic series with the HR seismograph.

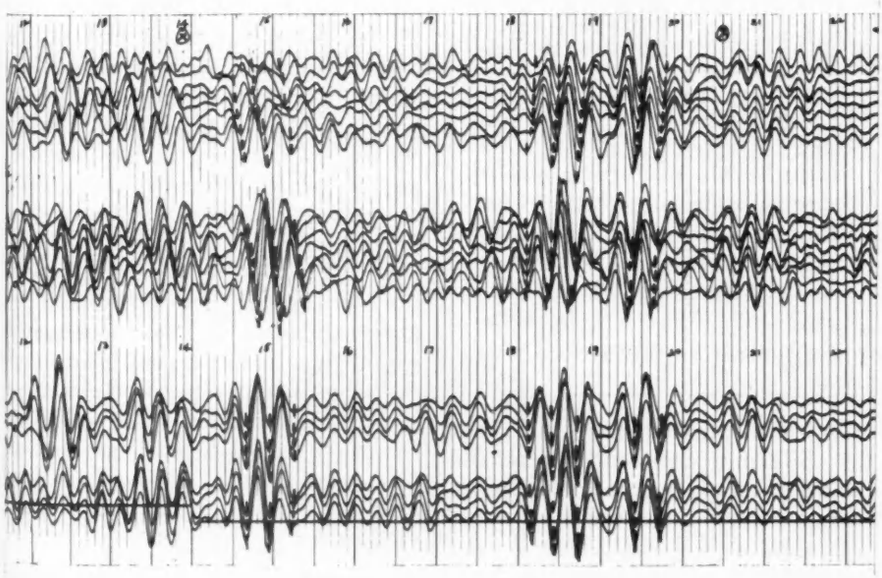

Fig. 3—Portion of seismic record with cross spreads showing unconformity at time of approximately 1.7 seconds.

In many instances "conventional" seismic records may be used for stratigraphic studies. Figure 3 represents a portion of a seismic record which shows a marked unconformity between the upper and lower events at a time of approximately 1.7 seconds. By proper identification of such events it is possible to predict where truncation of a particular bed would most likely occur. In certain areas where reliable velocity information may be lacking, seismic "unconformities" of this kind have enabled seismologists to orient themselves locally in the geologic section.

Smaller or less obvious changes in geological interval may often be un-

covered by a thorough interpretation of all seismic records, at least in those areas where isotime studies may be important. Both Paul Lyons, currently president of the SEG, and Roy Lay, former president, have emphasized this aspect during their terms of office. The authors believe that the present state of affairs in the geophysical industry as a whole tends to cause poor seismic interpretation. There are two primary reasons why this is true: (1) A scarcity of thoroughly trained interpreters, and (2) The narrow margin of profit and relative insecurity of the seismic contractor. In many instances a small increase in seismic cost would yield large dividends for the producer in better interpretation.

The Cambrian play in Nolan, Coke, Tom Green and other West Texas counties has created similar interest in other areas. One of these in Northeastern Oklahoma is where the Cambrian is reasonably shallow and it is a known fact that excellent sands are present. The HR seismograph is ideally suited for mapping the relatively shallow features to be found in such an area. Stratigraphic accumulations may occur here on the flanks of older structures or as a result of "wedging out" up dip.

Gravity Work. The gravity meter has found very little application as a tool in the search for stratigraphic traps, because in most cases the changes in densities associated with such traps are too small to be detected by the gravity method. For that reason, most geologists have completely disregarded gravity in planning their exploration programs in areas where stratigraphic traps are the primary objective. It is the purpose of this portion of this article to call to the attention of the reader some ways in which gravity may be utilized in conjunction with a seismic program and also as a direct method of locating abnormal porosities.

Stratigraphic traps of the pinchout variety are normally associated with erosional unconformities. The seismograph has been successful in mapping this condition in many areas. If there is sufficient density contrast between the erosional surface and the younger beds, a gravity survey will accurately indicate the sharp elevation changes in the surface of the unconformity. This serves to confirm the results of the seismic survey in areas where seismic records are good, and can make the difference between success and failure in areas where questionable seismic records are obtained.

Gravity is of special value in conjunction with a seismic survey in areas where shallow salt beds thicken and thin rapidly, because of the opposite effects produced by the high velocities and low densities associated with these beds.[3]

The most important direct use for gravity in locating stratigraphic traps is that which exists where lenticular sands or porous bodies of limestones are of sufficient thickness and located at a depth shallow enough to produce a gravity anomaly. The gravity effects of such bodies, particularly in limestones, have been well described by Klaus and Hughes (1951).[4]

One condition which may have far-reaching effects on the use of gravity in exploration for stratigraphic traps is that which the writers have recently encountered in western Kansas. The Novinger Pool in Meade county provides a very good example. In that field the producing horizon consists of a maximum of 80 feet of reef-like limestone at an average depth of 5300 feet.[5] This body of porous limestone is not in itself sufficient to produce an interpretable gravity anomaly.

However, it was found that a gravity minimum with an intensity of 0.3 milligals was coincident with the field. This suggested that there should be additional beds either above or below the pay section which have higher than normal porosities. This condition was confirmed by an examination of micrologs of wells in and adjacent to the field.

Since the porous deposition in the Marmaton appears to be controlled by marine currents, the additional porous beds would suggest that these currents must have followed identical courses at intervals during most of Pennsylvanian time. The evidence indicates that structural features in the bottom of the Pennsylvanian seas could have caused the currents to maintain the required well defined courses over a long period of time, and in this way the abnormal porosities could be developed in a number of beds. The effect of such porous zones, arranged vertically one above the other, could then account for the observed anomaly. There is evidence that such a condition controlled much of Pennsylvanian deposition along the northwest flank of the Anadarko Basin, for most of the gas and oil fields which produce from the Pennsylvanian section are situated on gravity minima.

In planning an exploration program in an area in which lenticular sands

Continued on Page 129

About the Authors

RICHARD A. POHLY majored in electrical engineering at Albion College and the University of Michigan from 1931 to 1935. He later took extension courses in geology and geophysics from Pennsylvania State College and the University of Texas. In 1937 he began work for Shell Oil Company in the research division of the Geophysical department. Since 1941 he has been engaged exclusively in gravity work with contract geophysical companies. In 1950 he organized a gravity division for Seismograph Service Corporation and served as manager of the division until April, 1953, when he was elected a vice president of that company. He formed Pohly Exploration Company, Tulsa, in 1953.

•

NEAL CLAYTON received a B.A. degree from Mississippi College in 1934. Later in 1937, he received his M.S degree in physics from Louisiana State University. He began his seismic career in 1936 with the Humble Oil & Refining Company. Since 1937 he has been engaged continuously in seismic exploration with the exception of two years at the N.O.L. in Washington. His experience includes both major company and contract. Since January 1, 1954, he has been president of Liberty Exploration Company and a partner in Miles Exploration Company of Tulsa.

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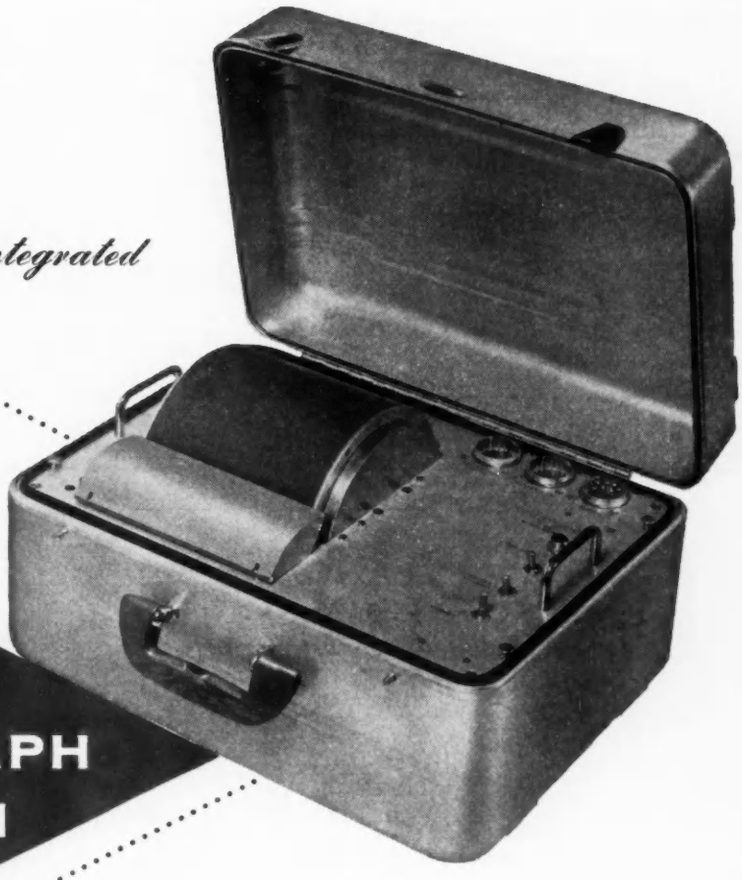

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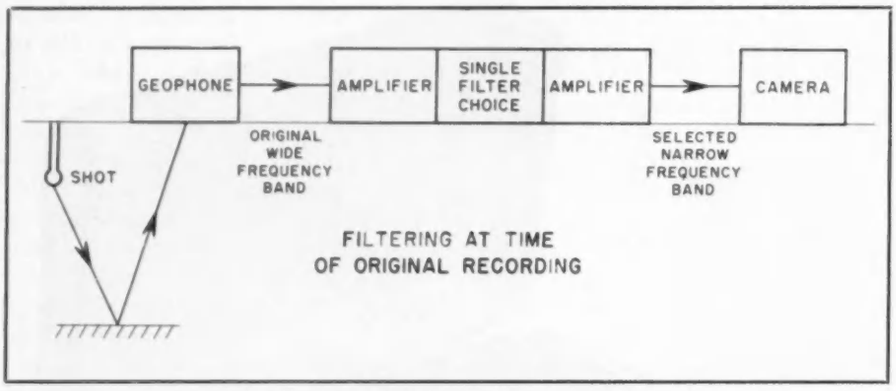


FIGURE 1A

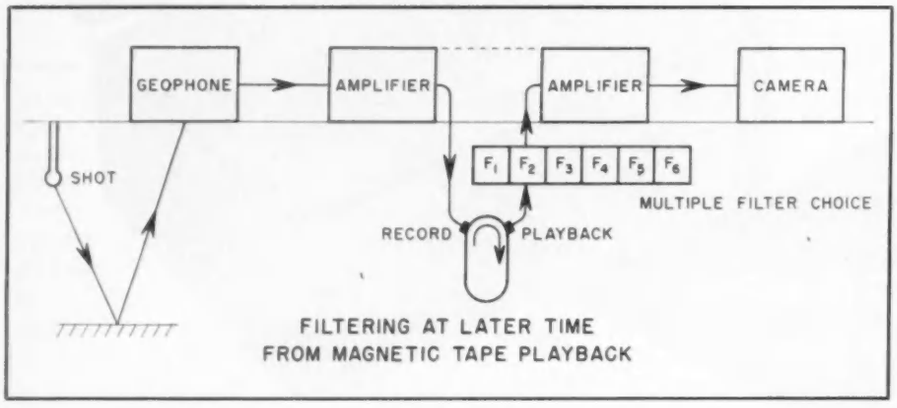


FIGURE 1B
MAGNETIC RECORDING SEISMOGRAPH

How to Reap the Maximum Magnetic Recording Benefits

Careful sizing and placement of shots and the most accurate interpretation provide the key.

By FRANK B. COKER, United Geophysical Corporation, Pasadena, Calif.

SINCE THE reflection seismograph is one of the principal exploration tools used for oil and gas prospecting, any basic improvement in its performance can be of considerable importance. Magnetic recording techniques show promise of increasing the capabilities and usefulness of the reflection seismograph, and considerable efforts are being made to incorporate these techniques. Although some of the work is experimental in nature, experience indicates that the magnetic recorder is most effectively exploited when used in regular every day exploration operations with the reflection seismograph.

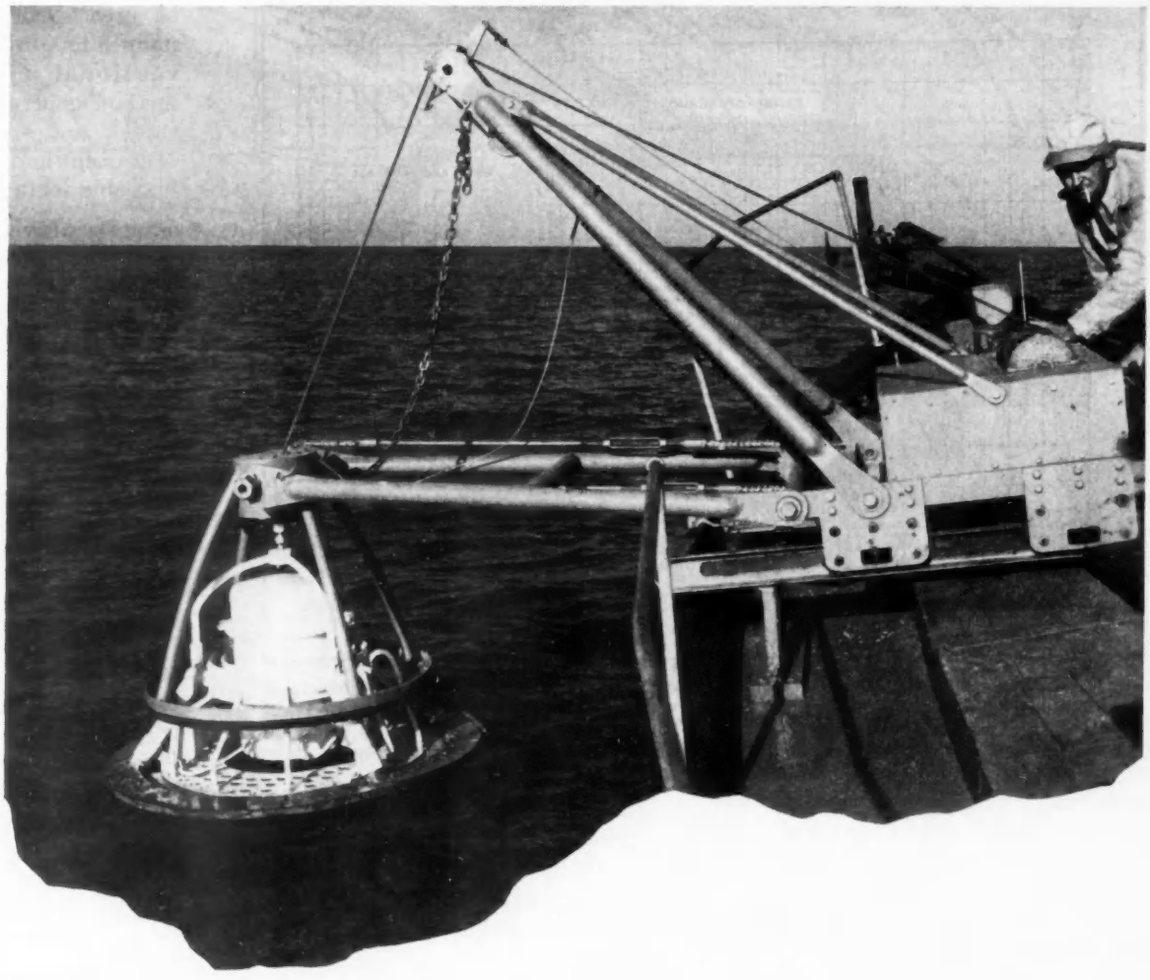
One of the limiting factors in conventional seismograph operations is the frequent failure to utilize the full frequency range of information in the reflected seismic waves recorded from shot impulses. Magnetic recording makes possible more complete utilization of the full range of the information present. In some instances this factor can be of vital importance and assistance in deciphering significant geological features associated with oil accumulations. Magnetic recording has further value in expediting the interpretation of seismograms in cases where variable "weathering layer" time delays distort the ordinary record. Of considerable importance also is the fact that magnetic recording makes possible the permanent storage of seismic data in convenient form for future utilization by automatic computing machines.

On the other hand, experience in this field indicates that there are often limitations in conventional seismograph operations which magnetic recording by itself cannot overcome. Inadequacies in shot hole practices such as improper shot size or depth or number of charges can easily impose serious limitations on the quality of final results obtained. Likewise, the skill of the interpreter obviously has a profound effect on the value of the final results. It is apparent that the solution to these problems lies in the simultaneous up-grading of all phases of the seismograph operation, if the full potential of magnetic recording is to be realized.

The basic operating principles of a magnetic recording seismograph are compared with those of a conventional seismograph in Figure 1.

In both systems the ground motion produced by the detonation of a charge of dynamite in a shothole is detected by a series of geophones. The resulting signals occupy a wide frequency band and are applied to amplifiers. However, due to the presence of extraneous seismic "noise," the amplified signals are filtered in the conventional system, and the resulting signals are further amplified and recorded directly on the seismogram. Therefore, only the information contained in a selected narrow frequency band is preserved. All of the remaining information is lost.

In contrast, the magnetic recording seismograph preserves all of the information inherent in the wide band signals by "storing" it in reproducible form on a multi-channel tape recorder. The tapes are "played back" repeatedly at a later time and paper seismograms may be made for any desired filter choice. In practice, two, three or even more filters are selected and the magnetic tapes are played back through each filter. This results



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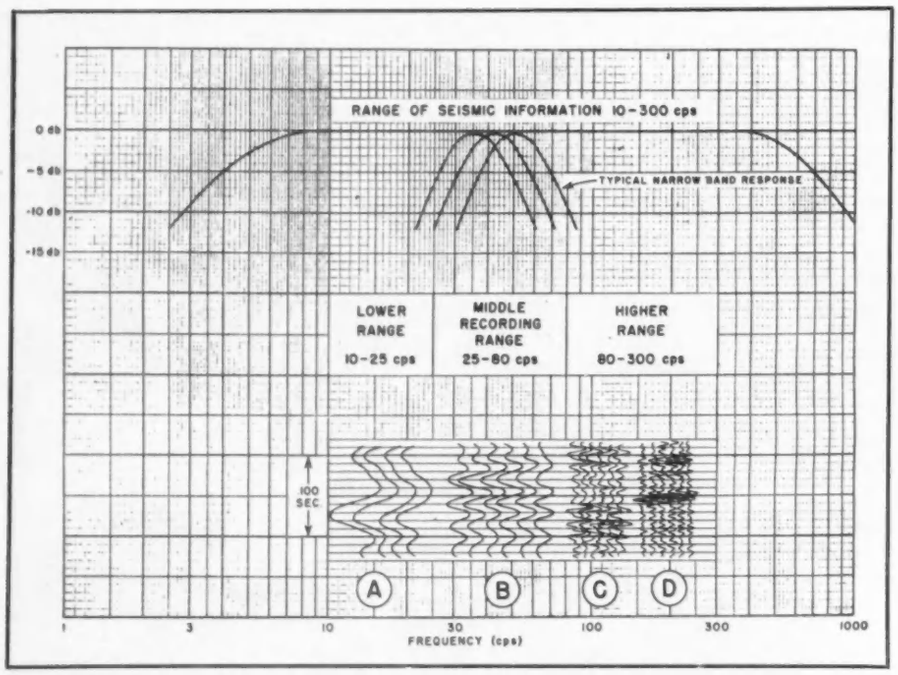


Fig. 2—Full range of seismic information recorded by magnetic recording seismograph is shown by top curve. Actual reflections observed in various portions of this wide band are shown at the bottom of figure. The typical narrow band of curves illustrates the small "chunks" of the band which are utilized by the conventional seismograph.

in a number of suites of seismograms which are equivalent to the results of several reshootings of the area with a conventional seismograph.

Figure 2 illustrates schematically the relative amounts of seismic information recorded by the two methods. The broad curve at the top represents the range of frequencies in which useful seismic information is received. At the bottom of the figure are actual examples of reflections observed under various circumstances in the low, middle and high frequency ranges indicated. The entire 10 to 300 cps band of frequencies may be recorded by the magnetic tape recorder. On the other hand, the narrow band response curves shown in the center of the figure represent typical single filter selections as employed in the conventional seismograph.

With this introductory information in mind certain questions arise relating to field experience and problems met in the practical field application of the magnetic tape recording technique. A few such questions and some answers, based on over two years of field experience, are given below.

In what different ways can magnetic recording be used in seismograph field operation?

- **As an auxiliary experimental unit attached to regular field seismograph crew.**

  Many companies enter the field of tape recording in this way. Interesting results can be obtained from a six or twelve trace tape recorder, but in essence its utility is limited to correlation work; although in areas of difficult shot hole conditions, it may be used to determine the optimum filters to be used by a conventional seismograph. The method generally requires two trucks, and the duplications of equipment and personnel are undesirable features.

- **As a regular field production crew.**

  Experience with a small experimental unit generally indicates the desirability of a 24 trace magnetic tape recorder. The unit is preferably contained in a single truck which is completely outfitted for seismic recording and playback. When used in regular field production, the tape recording technique is more efficient than an experimental operation since it becomes a systematic and routine procedure, and requires only a minimum of additional personnel.

What advantages are sought in the use of magnetic tape recording and playback as compared with usual present procedures?

- **More versatility in the selection of filter characteristics.**

  Useful seismic information is often found in a wide frequency band. However, wind noise, ground roll, etc., often require

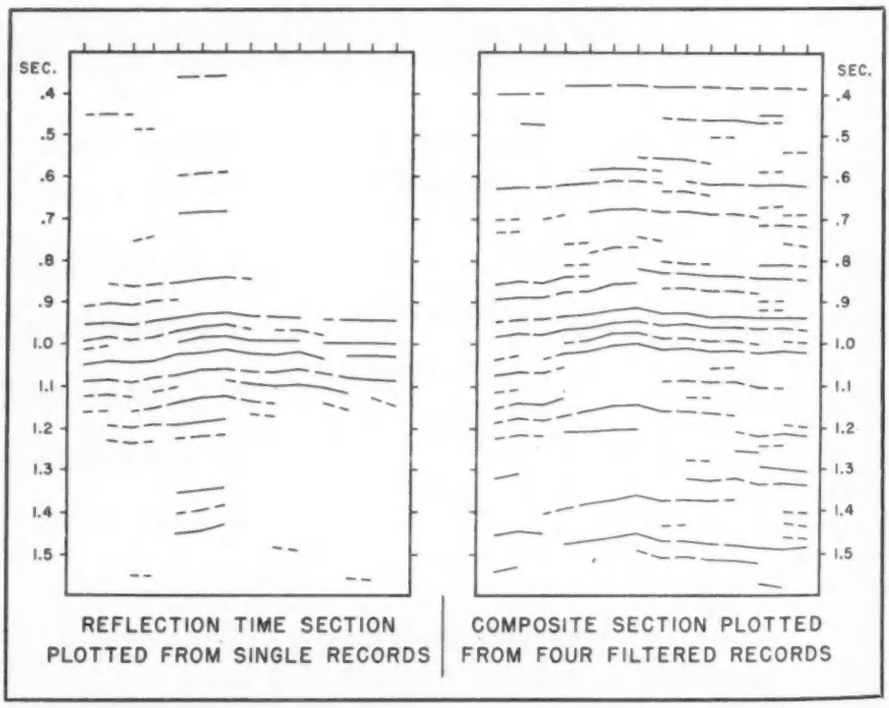
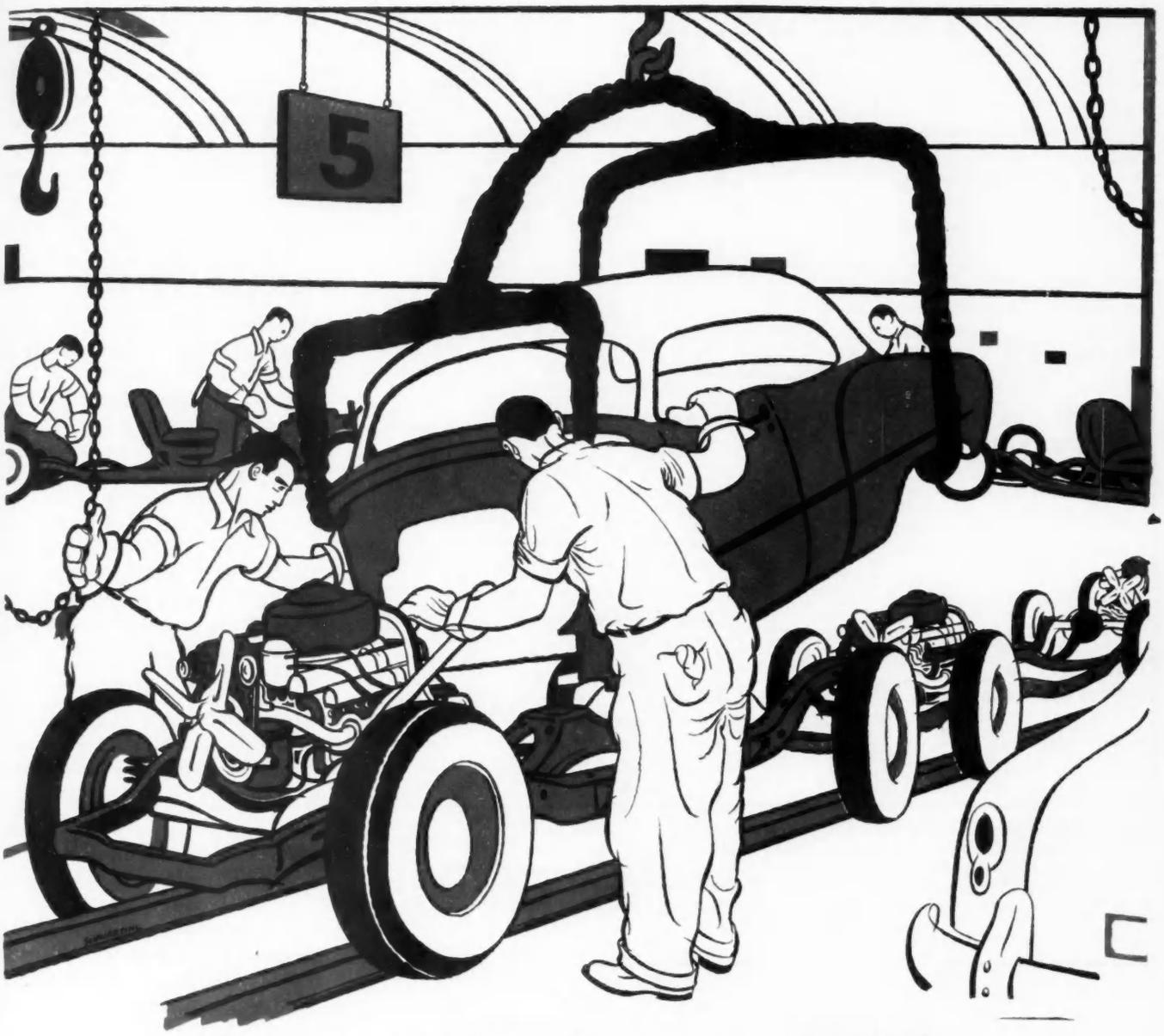


Fig. 3—Actual field data illustrating greater density of reflection information resulting from multiple filtered magnetic tape playbacks (right), as contrasted with data obtained from single filtered records (left). The obvious improvement in information obtained from multiple playbacks increases the possibility of discovering meaningful structures.



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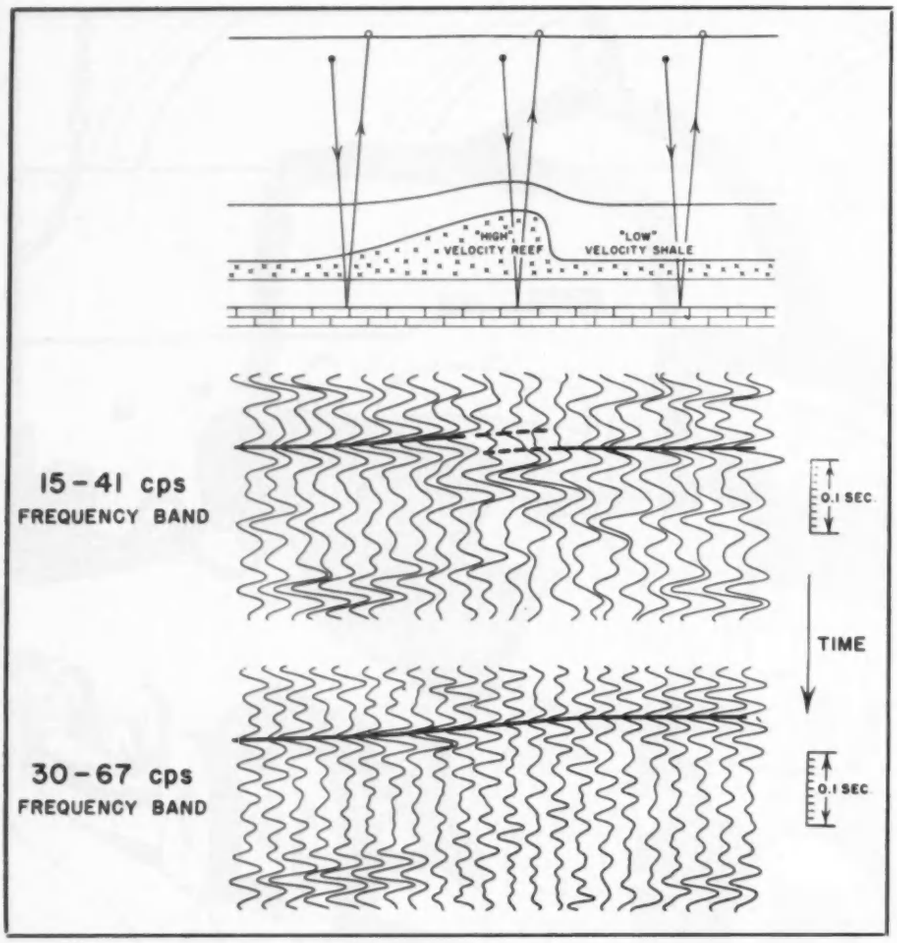


Fig. 4—Systematic multiple filter playbacks are desirable. The efficacy of such procedures is illustrated by the actual field example shown above where the 15-41 cps frequency band clearly reveals the characteristics of the narrow reef structure. However, the 30-67 cps frequency band provides completely erroneous evidence of the presence of the reef, even though this band appeared satisfactory for other structural changes along the line of survey.

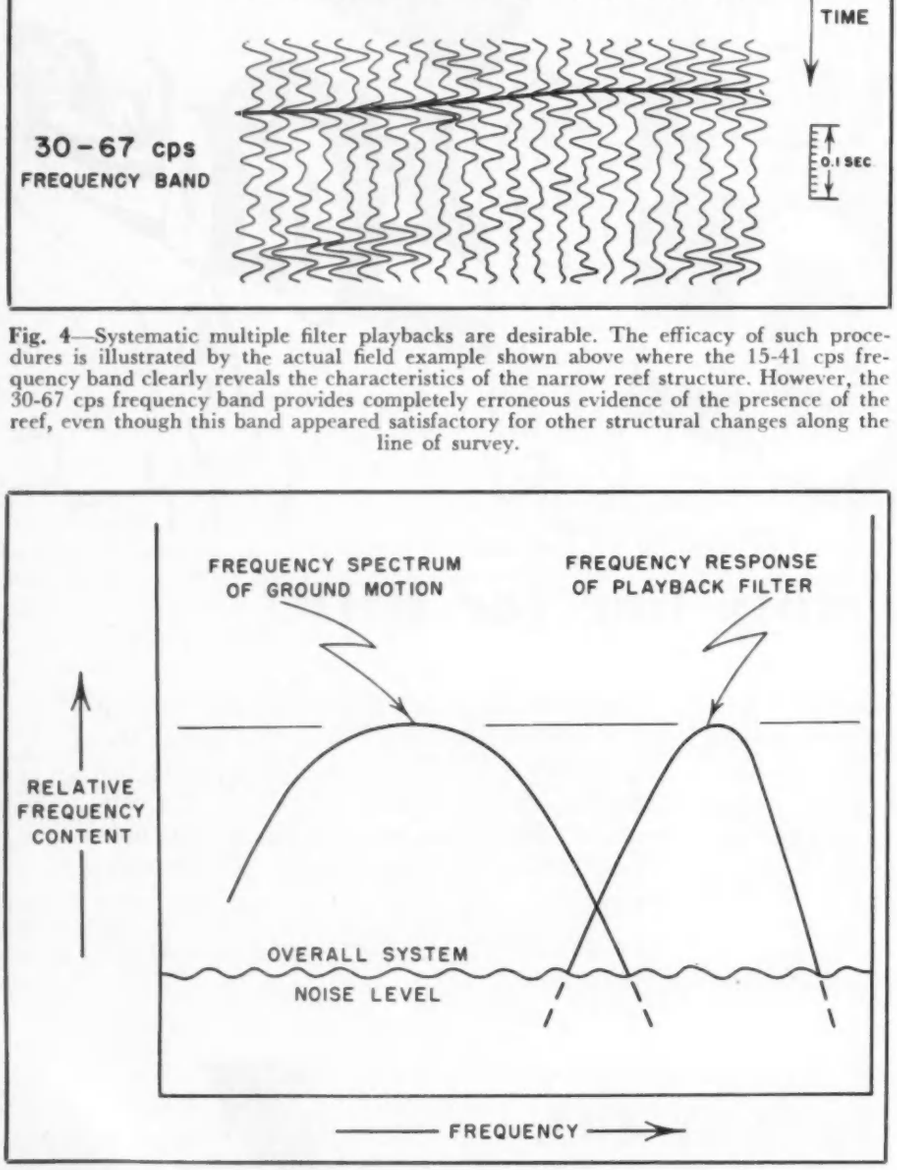


Fig. 5—Natural limitations sometimes arise which can limit the high frequency signal to noise ratio. The hypothetical illustration shown here might occur if attempts were made to limit the playback frequency response to high frequencies in a case where the useful information exists predominately at lower frequencies.

that the band of frequencies recorded on the final paper oscillogram be limited. The ability to play tapes back repeatedly and to determine experimentally the best filter settings for any particular purpose is a basic advantage.

- **Compensation of reflection time differences due to variable "weathering" time delays.**

  This result can be obtained with a magnetic recorder having individually moveable heads. Experience indicates that this feature is not required in all routine work. It is somewhat more time consuming than normal practices unless the recording system is particularly adapted for this type of operation. However, under suitable conditions in areas having erratic weathering patterns, compensation for differential delays can be especially valuable.

- **Permanent storage of seismic information for later handling by automatic computing machines.**

  With the large amount of effort being applied in the development of automatic computing devices, it is only reasonable to assume that such machines will ultimately become practical for seismic data computation. Hence, the permanent storage of wide-band seismic information taken today for use at a future date on such automatic computing machines is a highly attractive feature inherent in magnetic recording.

How can the playback of magnetic tapes be handled?

- **In the field.**

  This procedure is very consuming of the observer's time. Moreover, the best playbacks are made only after specific recommendations have been made by the seismologist on the basis of his inspection of monitor records.

- **In town after the field workday.**

  In this recommended procedure, a playback-maintenance observer is employed to playback the magnetic tapes made on the previous day. This allows the seismologist

to inspect the monitor records and to make recommendations for specific filters, time delays, and/or changes in other variables to be used in playing back the tapes. Moreover, with this method a minimum investment is maintained in universal recording trucks containing complete magnetic recording and playback as well as standard seismic recording facilities.

- **In the field party office.**
  This procedure maintains some of the advantages of item 2 but requires an extra investment in duplicate office playback equipment.
- **In a central playback office.**
  This procedure involves approximately a double investment in the magnetic reproducing equipment and may loose the close coordination desired between the field operating procedure and the playback facilities. However, some of the more complex operations with automatic computing machines are best handled in this fashion.

How can the additional seismic information inherent in wide band magnetic recording be effectively extracted and utilized?

- **By dual or multiple interpretation.**
  The key to effective utilization of the additional seismic data lies in a systematic and routine interpretation process. In dual or multiple interpretation, the several suites of seismograms are each interpreted by a separate seismologist. In this way different interpretations are readily discovered. The differences may arise from inherently different information contents of the seismogram suites as well as from human interpretation characteristics or errors.
- **By cross-comparison and reconciliation of plotted cross-sections.**
  The cross-sections corresponding to the several suites of seismograms are compared by superposition on a light table. Basic differences in interpretation and possible errors are readily determined by this procedure.

About the Author

FRANK B. COKER is a native of San Diego, California. He attended the University of Southern California, receiving the B.S. degree in electrical engineering in 1951 and the M.S. degree in 1953. Previous experience includes work for the Hydropak Corporation as a research engineer and for the Electraphone Corporation as an electronics engineer. He joined United Geophysical Company, Inc. in 1950 and is now in the Research and Development departments. Coker is a member of Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi and the Institute of Radio Engineers.

In what respects may final results obtained by effective use of magnetic recording differ from usual results?

- **Greater density of reflection data.**
  This is illustrated by Figure 3 which compares two reflection time cross-sections (simplified for illustrative purposes), obtained from actual field data. The one on the left was plotted from single filtered records. The composite section at the right was plotted from four suites of records obtained by playing a set of magnetic tapes back through four different filters. The composite cross-section contains considerably more information than the other and hence, improves the possibility of discovering meaningful structures.
- **Registration of critical data otherwise passed over.**
  In magnetic recording, all of the information in the wide frequency band shown in Figure 2 is recorded and later inspected in small "chunks" by means of multiple filter playbacks. This principle obviously increases the possibility of registering data which would otherwise be lost.
- **Basically different interpretations in some cases of faulting and complex geological relationships.**
  An example of this important factor is illustrated in Figure 4. At the top is shown schematically the structural configuration of a narrow reef; at the center and bottom are two seismogram sections actually taken over the reef and showing the energy existing in the 15-41 cps and 30-67 cps frequency bands respectively.

  These condensed sections were traced from the original played back seismograms and represent about half a mile of line.

  Based on this structural configuration, reflections from below the reef should show apparent "pull up" because of presumably higher velocity in the reef, contrasted with the surrounding shale. This factor is brought out in the low frequency traces, where it is seen that correlation justifies the "picks" made. Note the obvious discontinuity of the reflection directly over the reef.

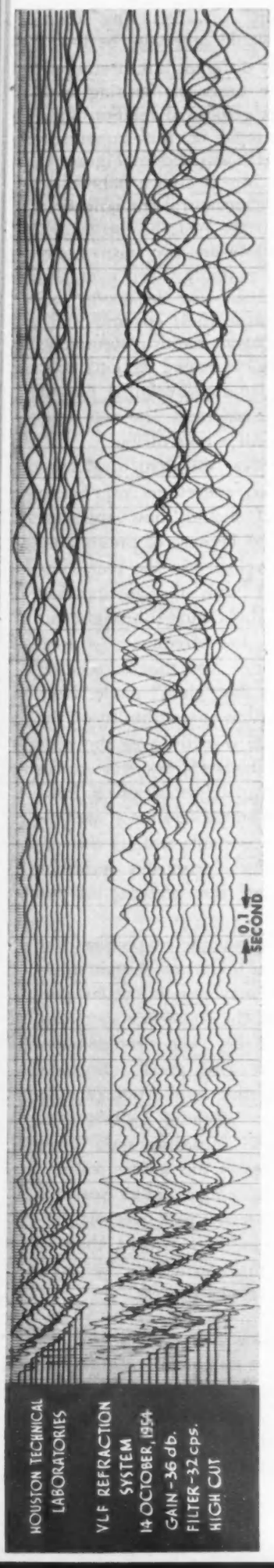
  The higher frequency traces are completely misleading, however. The picks shown are entirely reasonable and yet the section gives erroneous evidence regarding the presence of the reef.

  This example emphasizes the fact that important seismic information may exist in various portions of the frequency spectrum, (Figure 2), even though other portions give good reflections. The routine application of multiple interpretation techniques to magnetic recording data bring examples of this nature to light.

  When conventional seismograph surveys pass over such occurrences it is evident that oil fields may sometimes be overlooked in the process.

What technical performance problems may arise in magnetic recording of seismic data?

- **Large amplitude, low frequency ground roll.**
  This condition is aggravated by



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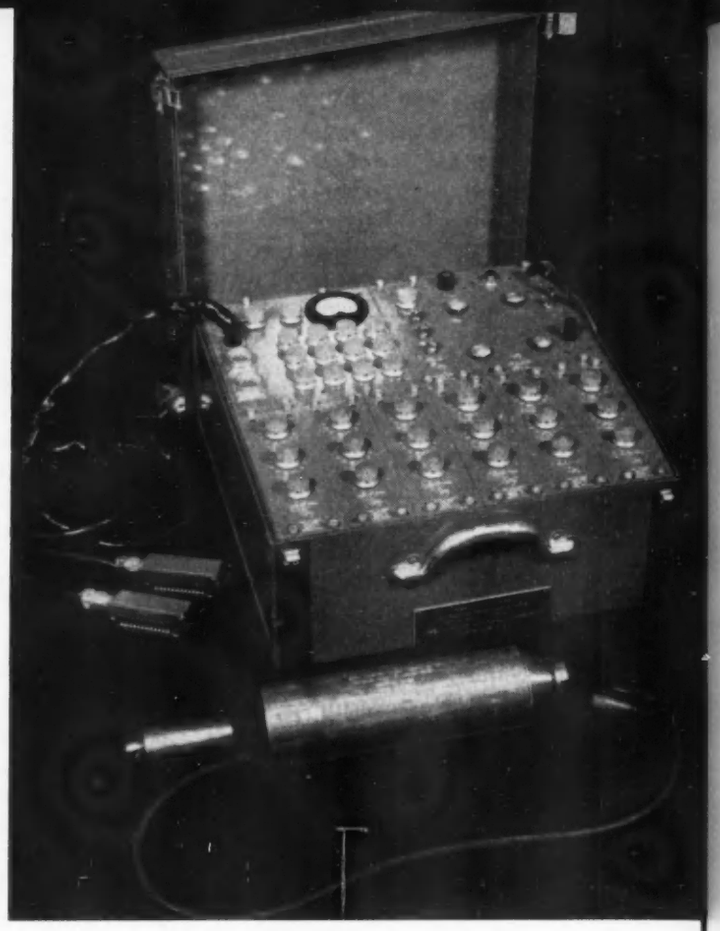

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shallow shot holes and peculiar surface conditions. In practice it may be combatted by the following procedures:

1. Proper instrument design.
2. Multiple geophone techniques.
3. "Expander" type operation in some cases.

- **Adverse signal-to-noise ratios at high frequencies.**

  Figure 5 illustrates schematically a hypothetical case in which the frequency spectrum of useful ground motion is centered at a low frequency while the frequency response of the desired playback filter is peaked at a relatively higher frequency. This situation might arise in some areas if attempts are made to limit playback frequencies to some high range such as 100-300 cps.

  As with any recording-reproducing system, the magnetic recorder has an overall system noise level which is schematically shown by the wavy line. The playback, exemplified by the conditions of Figure 5, would produce mostly noise and very little useful seismic information. A possible solution to this problem would involve pre-emphasis of high frequencies relative to low ones during the recording process.

What factors are involved in field recording operations?

- **Care and handling of tape.**

  The best results are obtained by setting up and following systematic tape handling procedures. The tapes may be made up in advance in quantities sufficient to last several weeks. In the field it is desirable to employ clean metallic storage containers for both fresh and used magnetic tapes. Reasonable care in handling of tape and in keeping it clean should be exercised. Used tapes should be stored for future use in conveniently-identified, dust free containers.

- **Monitoring of tape.**

  It is desirable to monitor each magnetic tape immediately after it is made. By following this procedure the observer is assured that when he leaves the field at the end of the day his tapes are of high quality.

- **Close coordination with office on shot size and depth.**

  The best results are obtained from a magnetic recording seismograph when careful control is exerted on the size and depth of the shot. In practice, the seismologist may recommend the best shot size and depth from inspection of the played back records. This point is a good illustration of the fact that it is most expedient to make monitor playbacks in the field and filtered playbacks in town shortly after the magnetic tapes have been made. In this way maximum coordination between office and field operations will exist.

What economic problems are involved in the use of magnetic tape recording and playback?

- **Amortization of instrument costs.**

- **Relatively large cost of separate record and playback facilities.**

  This factor constitutes one basic reason for favoring the complete observing truck installation which performs both recording and playback operations. Separate facilities obviously aggrevate the amortization problem.

- **Evaluation of operating costs versus value of final results obtained.**

  Of course, this aspect is always necessary in evaluating any new equipment, but the relatively high initial cost of magnetic recording equipment makes it particularly important.

In conclusion, the question might be asked: "Does magnetic recording solve all seismograph problems?" The answer is that merely adding a magnetic recorder to reflection seismograph operations without, at the same time, providing adequate shooting procedures and up-grading the interpretation will not insure the solution to "No Reflection" areas. On the other hand, by up-grading the entire seismograph process, distinct advantages are obtained which the magnetic recording seismograph effectively exploits. —**The End**

Stratigraphic Traps

Continued from Page 118

or porous zones in limestones are to be expected, the geologist should not overlook the possibility that these porous bodies may have resulted from changes in deposition produced by marine currents.[6] If there is also evidence that the area should have been stable over a long period of time, and if structural ridges or domes might have been present in the bottom of the sea to control the course of these currents during deposition, gravity could be expected to provide a useful tool for mapping the resultant porous deposits.

One of the most important requirements for utilization of gravity in stratigraphic trap exploration is that of extreme accuracy in the field survey. Elevations must be carefully controlled to provide a maximum error of 0.5 feet, and the gravity value of the stations must be accurate within 0.05 milligals. Considerable care must also be used in correcting for near-surface effects to provide data which reflect the true condition of densities in the subsurface beds.

In order to make use of the various geophysical methods as means of locating or predicting stratigraphic traps, the geophysicist will be called upon to be extremely resourceful at all times. His problem is a most difficult one and can only be solved by using the best geophysical tool available for each particular area. Recently, progress has been made with both the seismograph and the gravity meter in solving this problem.

It is expected that other geophysical methods will also prove quite useful to the geologist in his search for stratigraphic accumulations. An abundance of talent is present in both the geophysical and geological fields with which to find a solution. The authors believe that a solution can and will be found for this problem.

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—**The End.**

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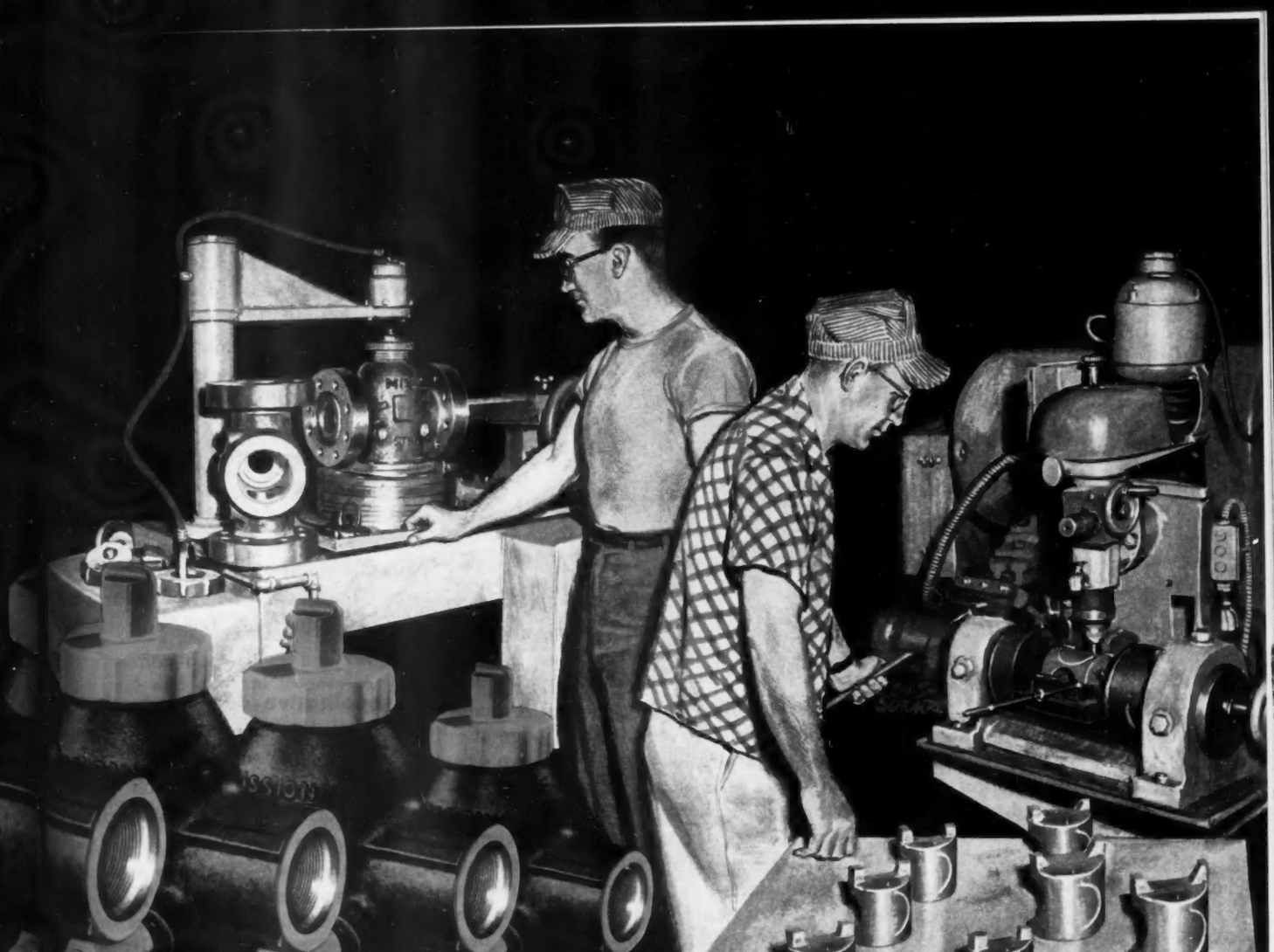

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How Computers Facilitate Stratigraphic Correlations

This new technique helps where usual visual method is indefinite. It employs punch card calculations or specially-designed computing machines.

By CHARLES W. OLIPHANT, Oliphant Laboratories, Inc., Tulsa, and **PAUL FULLERTON,** Southwestern Computing Service, Tulsa

DETAILED CORRELATION, the interpretation of continuity in matched rock sequences, is undertaken for structural or stratigraphic purposes. In the preparation of structural contour maps, the correlation process often consists of matching rock sequences and interpreting the continuity of a single stratigraphic plane. In a stratigraphic study the continuity of several planes must be interpreted. The operations in each case are the same, however; rock sections must be matched and the physical continuity of part or all of the section interpreted.

When there is slight horizontal or vertical variation between closely spaced rock sections, the matching data are easily aligned by simple inspection. One set of data is placed beside the other and the relative placement varied until the data of one rock section are paired with identical observations from the other section. With matched sections the geological correlation is completed by drawing horizontal lines which interpret the continuity of distinctive strata. Once the continuity has been interpreted, the relative placement of the two rock sections can be varied to suit the purpose of the correlation. A geologist of moderate experience does an efficient job and is highly confident of his results; there is no need, here, for special techniques.

As the vertical and horizontal variations of the sediments or the spacing between outcrops or drill holes increase, the degree of match between correlative rocks deteriorates. A much longer time is required to judge the best relative placement of the two sets of data; the continuity lines may no longer be horizontal and even the most experienced geologist becomes uncertain of his results. At some level, differing for each geologist, the match becomes sufficiently poor and the continuity lines so uncertain that one lacks confidence in the results, and announces that no correlation exists. In truth, a correlation may not exist, and, depending on the consequences of his announcement, the geologist may ask for additional data, more outcrops or more drill holes, deeper and closer. If these are impossible or uneconomical he may wish to carry his study further by means of correlation functions and significance functions.

Our objective is to match as well as possible two discordant sets of serialized data, specify a degree of confidence in the match, and finally, to interpret the physical continuity of distinctive rock units. To match the data we will compute numbers which measure the degree of match in the two sets of data as their relative placement is varied. These numbers define the correlation function of the data. The best position of match will be indicated by the largest number.

To calculate this sequence of numbers an initial placement of the two rock sections and a probable maximum displacement is specified by the geologist. For the inital placement of the two sections, a value of the correlation function is computed, and one rock section which we call the active section is placed in new position relative to the other rock section, designated as passive because it does not move; another value of the function is then computed. This calculation may be continued systematically as the active log changes its relative placement in small discrete intervals from initial to final position. From a geologically chosen initial placement, the active rock section slides, by a geologically reasonable amount, past the passive rock section creating new pairs of data at each position of placement. These pairs determine the numerical value of the correlation function.

For qualitative data, each of the paired observations results in a conclusion applying to that pair: it comprises a match or a mismatch. When all pairs formed by a given placement of the active and passive rock sections are inspected we may state the proportion of matching pairs to total pairs. If the active rock section is then varied systematically in its placement relative to the passive rock section, new pairs will be generated, each position having a definite proportion of matching pairs to total pairs. At the relative position where this proportion is largest we have a rational basis for stating that the two rock sections are best matched.

For quantitative data, pairs of numbers are generated. The paired numbers, for example the apparent resistivity values from electric logs, may be multiplied and added to the products of all other pairs. This sum of the pair products when divided by the total pairs gives the mean pair product, a proportion analogous to the proportion for qualitative data. Similarly, at the relative position where this proportion, the mean pair product, is largest the two rock sections are best matched. By this process we are calculating what mathematicians call an approximate cross correlation function; the same process performed on two identical rock sections results in an autocorrelation function. That autocorrelation functions must have a maximum value when the identical rock sections have zero relative displacement may be

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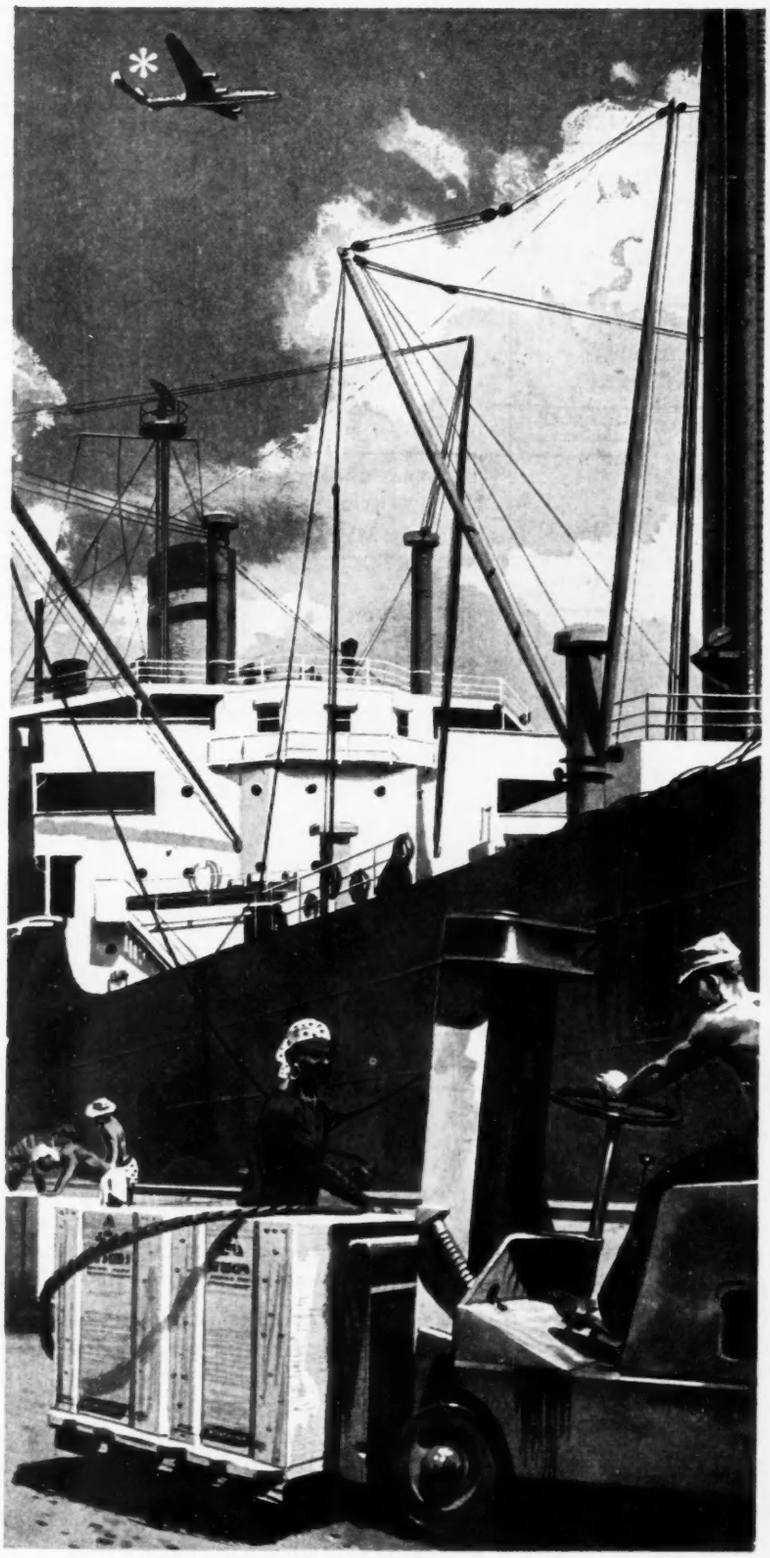

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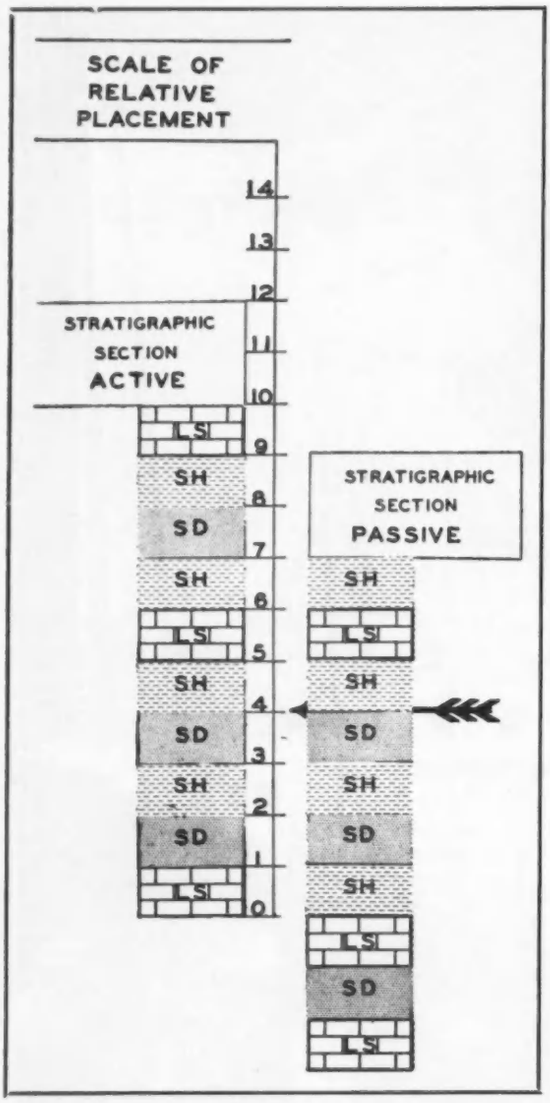


FIGURE 1A

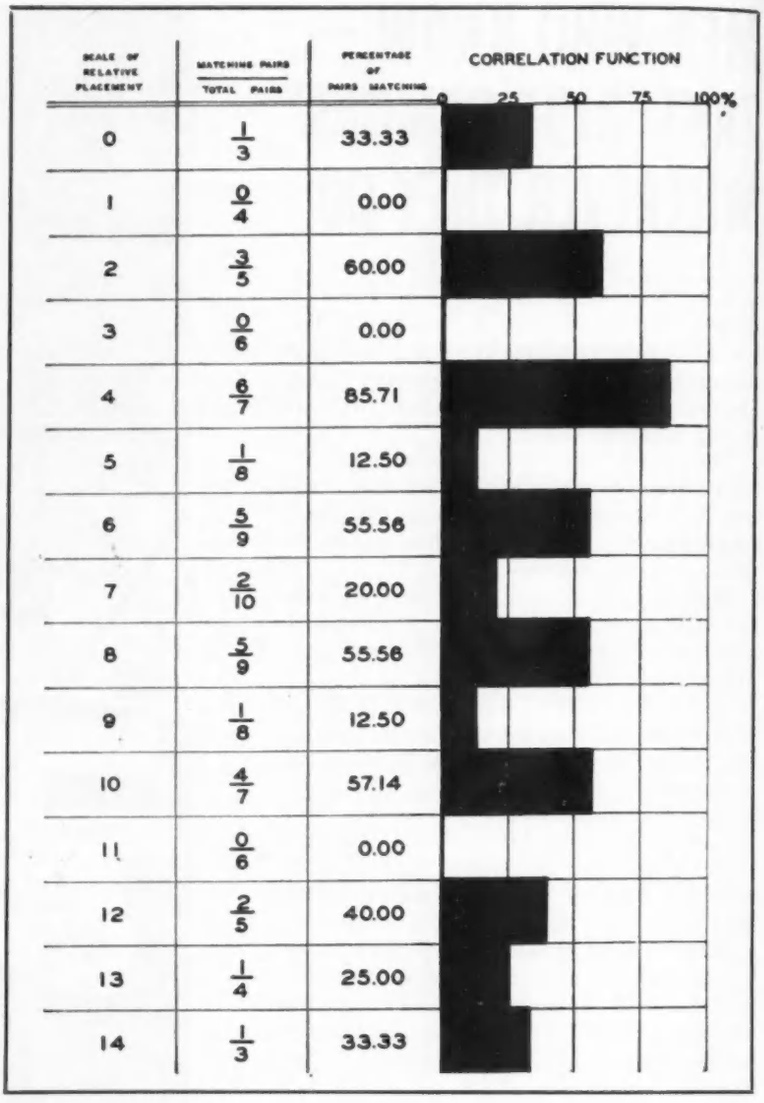


FIGURE 1B

demonstrated from the Schwartz inequality.

In Figures 1-A and 1-B are shown two stratigraphic sections recording only the sequence of lithology. A fiducial arrow is placed on the passive log and a scale of relative placement is rigidly fixed to the active log. Numerical values on the placement scale are in rock units and do not record depth or thickness.

To begin the correlation process, the active log is moved so that zero on its placement scale is opposite the fiducial arrow. Three lithological pairs are generated: sh-sh, sd-ls, ls-sh; of the three pairs one comprises a match and two a mismatch. The ratio of matching pairs to total pairs is tabulated and plotted in the right-hand portion of Figure 1-A. The active log is then moved downward to position one where four pairs are generated with none matching. The process is completed by moving the active log systematically downward in steps of one rock unit until all reasonable positions have been occupied.

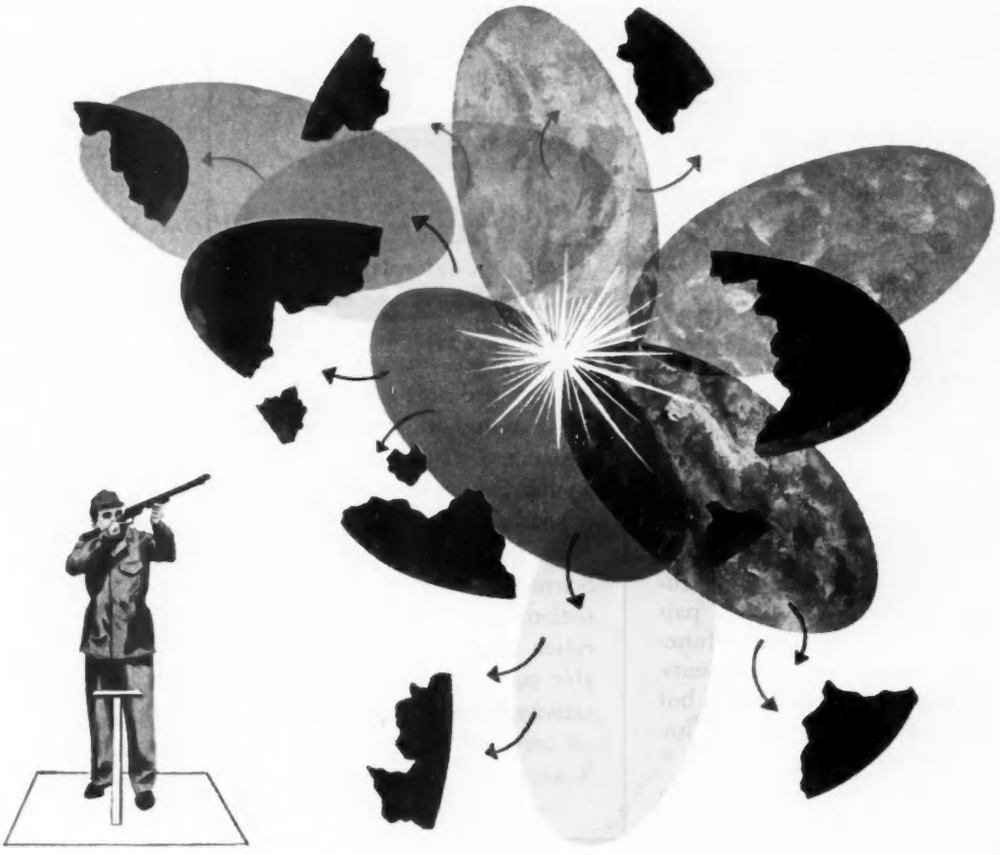
In this example the best match occurs at position four on the placement seale where seven pairs are generated, of which six match. The continuity of rock units is then interpreted by connecting lines between matched units of the two sections. In this case each of the continuity lines is horizontal except at the top of the lowest limestone of the active log where convergence has eliminated a shale unit present in the passive section.

Other types of qualitative data can be treated in the same way, for example, faunal successions.

To specify a degree of confidence in the match selected for interpreting continuity, use is made of statistical tests which compare the actual match with the match expected on the basis of a selected hypothesis involving pure chance. The probability that the chance match will be as good or better than the actual match is then calculated. When it is probable that the chance match is as good or better than the actual match, very little confidence can be placed in the actual match. To accept or reject a match we may choose very strict, strict, or liberal limits for the bounding probability and in this way act with a controlled objectivity, dependent on the consequences of our study.

If a probability is calculated at each placement of the two rock sections, a significance function is generated. As the value of this function varies in relation to our chose boundary probabilities, we observe the significance of match at each relative placement of the rock sections.

For qualitative data the chi square



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test is used to calculate the probability that a chance match will be as good or better than an actual match. For the data of Figure 1 an hypothesis for matches occurring by chance alone is that a given lithology has an equal probability of being paired with any one of three lithologies. At a relative placement where three pairs are generated, we expect one match from chance alone; if six pairs are generated two matches. As the proportion of matching pairs to total pairs increases in excess of the chance expectation, the total match gains significance.

At placement position 4 of Figure 1, there is a very low probability that the match is due to chance. At all other positions a chance match is nearly as probable as the observed match. For instance, at position 9, a chance match would be as good or better than the observed match in 300 out of 1000 trials; at position 4 this would only happen in 17 out of 1000 trials.

For quantitative data similar correlation and significance functions may be calculated. For the correlation function we have chosen to calculate serial values of the mean pair product and for the significance function, serial correlation coefficients. Other functions could be devised, but a discussion of these is beyond immediate interest.

The quantitative geologic data with which correlations are to be achieved come from electrical well logs. Numerical values for the apparent rock resistivity at one-foot depth intervals are read from the log on the so-called, "short normal resistivity curve"; these tabulated values form the raw materials for machine computation.

Because even a modest program requires many thousands of arithmetic operations, punch card machines were selected for the computational studies to reduce the expenditure of man hours. To obtain functions of the type described, resistivity values on the passive log are first multiplied by the paired value on the active log. This must be repeated for each offset.

A geologist must select the significant portions of the logs, and make a prior decision as to their initial relative placement; his estimate of the maximum reasonable displacement is then used to limit the number of offsets studied.

About the Authors

CHARLES W. OLIPHANT, independent geologist of Tulsa, received B.S., M.A., and Ph.D. degrees from Harvard University in chemistry, geology and geophysics. He is president of Oliphant Laboratories, Inc., engaged in petroleum exploration. He is a member of the AAPG, SEG, and other organizations.

•

PAUL FULLERTON is a graduate of the California Institute of Technology where he majored in applied chemistry. He served in the Air Force during the last war and obtained experience with analog computers utilized in aircraft fire control apparatus. Before joining Southwestern Computing Service, Tulsa, of which he is a partner, he was in the Applied Science department of the International Business Machine Corporation which gave him considerable contact with the computing activity within many of the major oil companies in Oklahoma and Texas.

From the tabulated depth and resistivity values entry into cards is made through the use of the "key punch." After punching, the transcription is checked through the use of a "verifier." This machine senses whether or not the holes have been properly made as a second operator repunches the data.

By means of the "reproducing punch" adjacent log values may be associated with each other and the corresponding values for serial offsets positioned for the multiplication, summation, and division to give mean pair products. Serial correlation coeffiicients are calculated from the same cards; results are presented either as a machine tabulation or a machine plotted graph. The maximum value of the correlation function then indicates the relative position of best match for the two logs; the value of the significance function at that point judges the reliability of technique.

Computing machines especially designed for this purpose could obviously improve on the punch card technique.

The behavior of the correlation function, serial mean pair products, for certain simple geological conditions has been briefly studied in order to better understand its behavior for real data. Simplified synthetic logs have been prepared and the correlation function computed for the following cases:

1. Varying amplitude of resistivity for a single high resistance bed for constant thickness.
2. Varying thickness for a single high resistance bed of constant amplitude of resistivity.
3. Varying interval between two high resistance beds of constant amplitude of restivity and equal thickness.

In the first two cases a single correlation function maximum invariably occurs at a relative placement where the logs are symmetrically or identically matched; an unsymmetrical maximum is caused by a rapid change in number or paired observations. Height and breadth of the maximum are proportional to resistivity amplitudes and bed thickness respectively.

When the thickness of a single otherwise uniform bed varies, a single attribute of that bed is insufficient to determine the matching relative placement of the thinned portion of the bed within the limits of the thickened portion. To do this requires other attributes of the bed permitting subdivision into smaller units at least one of which must show no appreciable thickness variation. These results apply generally to geological correlations whether made by man or machine.

When two beds of varying separation are studied, the correlation function shows several maxima; the largest of these indicates the best position of match when divergence is slight. As the separation increases, the major maximum decreases in amplitude to become a minimum when the interval between beds increases by half of the bed thickness. In effect, this is the

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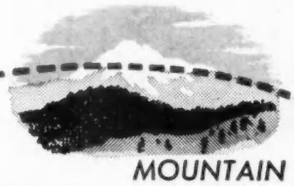

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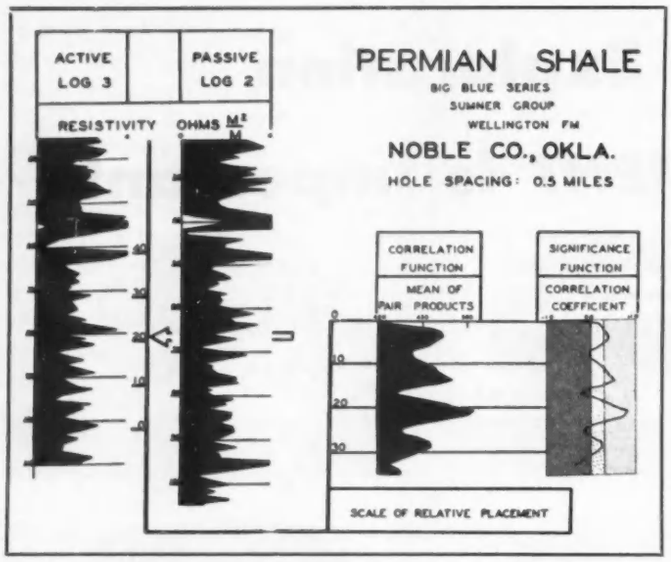

FIGURE 2

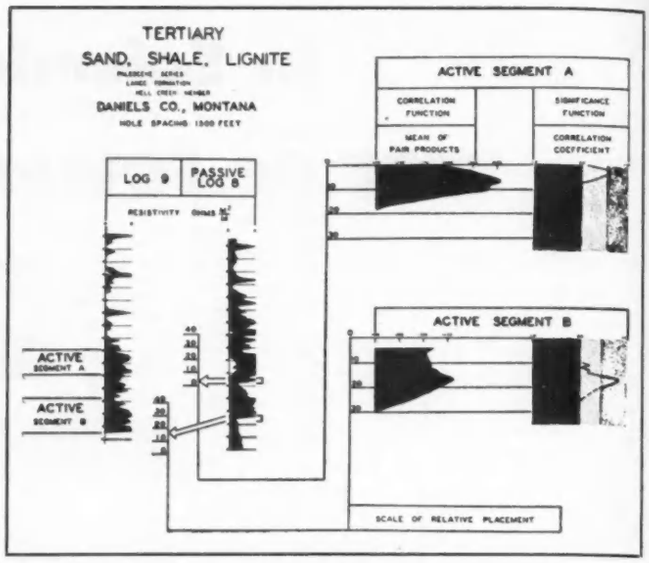

FIGURE 3

correlation function's way of saying that converged and diverged stratigraphic sections do not match.

Just as a geologist must use special procedures to obtain correlations in this case, so must the machine. This may usually be done by subdividing the over-all section into distinctive smaller rock units for each of which an individual match is sought; proper selection of the subdivided rock units will result in a correlation function maximum at the best position of match and divergence will be indicated by an increase in separation of the subdivided units.

For this preliminary work, nine electric well logs have been studied. The logs were selected in suits of three to form closed correlation loops from three distinctively different areas where geological correlations may be classed as obvious, difficult, and very difficult; divergence was known to occur in the latter case.

Logs were recorded with an amplified resistivity scale of either 10 or 4 ohms per M^2/M and a depth scale of 10 feet to the inch. A three-electrode normal type sonde with measuring electrode spacing of 8 inches was used in 4¼-inch holes.

Initial studies were made on logs from Osage County, Oklahoma, which consisted of approximately 350 feet of section comprising parts of the Iola and Wann formations of the Ochelata group, Missouri series, Pennsylvania System. From the base upward, 30 feet of Avant limestone are overlain by 170 feet of shale and 60 to 100 feet of Clem Creek sandstone. The entire length of each log was used for machine matching which produced a highly significant maximum of the correlation function at a relative placement precisely in agreement with the best placement found by visual inspection.

Figure 2 illustrates the matching of more difficult logs from Noble County, Oklahoma. The entire length of each log was used for the machine matching computations.

Four peaks are found in the correlation function with the largest occurring at position 21. The correlation coefficient is most significant at this position and the logs have been so placed. The geological correlation may be completed by drawing horizontal continuity lines between distinctive units of the section.

In judging the significance of any peak in the correlation function, limits must be set to accept or reject a particular placement peak. In the right hand graph of the correlation coefficient the boundary between the stippled area and that of the broken hachures is taken as "the one percent significance level" which means that two hypothetical logs, consisting of independent, random values would produce a correlation coefficient as high as we observe for the two real logs in only 10 trials out of 1000. It is this boundary which we may alter depending on the consequences of our correlations, and thus control the objectivity of results. Since this level varies with the size of the sample and since the number of pairs formed is variable near the end of each log the boundary is not as straight as drawn, but should move outward slightly at high and low placement values. A higher significance level is obviously required to exclude the two extraneous peaks at positions 3 and 13.

Additional studies have been made on the logs of this area to test for the presence of convergence. Segments of active log 3 from depths 52 to 63 feet and from 75 to 85 feet were separately used to calculate serial mean pair products and correlation coefficients as they moved past 60 feet of passive log 2. Each produced a highly significant maximum of its correlation function and these peaks were separated in feet by the same amount as the rock units, thus indicating the absence of interval variation.

In Figure 3 are shown two logs which are very difficult to correlate from Daniels County, Montana. Two active segments have been selected from log 9, and each has been separately moved past about 30 feet of passive log 8 seeking a relative placement where each segment is best matched. When this position was found, as indicated by the most significant part of the correlation function, a corresponding segment of the passive log was similarly shaded; the geological correlation may be completed by drawing lines between boundaries of similarly shaded rock units. From this evidence and the observation of outcrops in adjacent areas, it is concluded that active segment B is a basal Paleocene deposit resting disconformally on an Upper Cretaceous erosion surface of moderate relief. **—The End**

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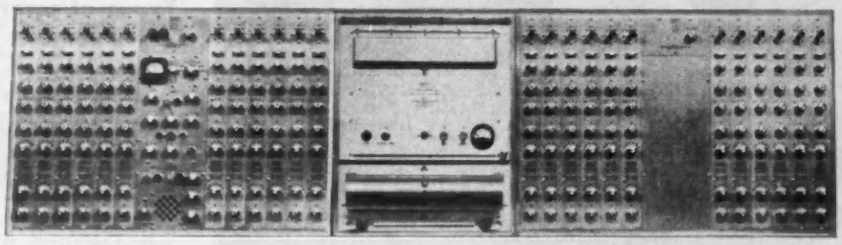

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SHOTS SUCH AS THESE are why geophysical field parties traipse all over the world. For it is from the resulting shock waves that trained experts can detect whether the area is one in which oil might be found.

Geophysical Contracting Abroad a Complex Job

As field parties range the globe, companies must be masters of many subjects—exporting, importing, legal, and financial.

By DON KLIEWER, World Oil Staff

Exploration companies are, of course, in business for one reason—to help their clients find oil fields. And a gigantic job it is, with logistics and details by the hundreds playing dominant roles because these extensive operations require almost continuous support of field parties scattered the world over.

From U. S. headquarters many geophysical companies send parties north into Canada and south into South America. Their parties range west to Europe and farther, east to Sumatra and beyond.

Geophysical Service Inc., Dallas, Texas, is one of the far flung, full blown global operations. It has to be. For when one of its field parties is made ready to enter another country, details mount.

The proposal is the beginning. These details begin developing when a prospective client asks for bids from geophysical contractors. Right there, GSI's Marketing department takes over. Its job is to make the proposal. Simply stated, the task is not so simply done. The wealth of information required to submit a proposal begins flowing into the Marketing department from all other company levels.

Shakedown on terrain, discussions with prospective clients to determine his exact objectives, exchange of experience between contractor and company regarding techniques and selection of equipment, determining size of field party—these and a myriad of other details are worked out mutually between company and contractor, serving as guides for the contracting proposal.

When a contract is awarded, operations move into high gear. The proposal is rechecked. Equipment is purchased, built or assembled in Dallas. Supplies are ordered. Steamer space for supplies and equipment is arranged. The operation is under way.

Types of contracts vary. An exploration contract job may be a turnkey effort, or the geophysical company may be asked to furnish only seismic instruments and personnel. With time an ever-important factor, equipment and personnel from the country where the exploration is scheduled are used when desired and available.

A turnkey job calls for the utmost in coordination. To get equipment to the port of destination requires help from all departments, consideration of many individuals and a great volume of work and planning by the Equipment department.

And this department must be the master of many trades—export, import, legal, financial and economic problems must be met and solved. Nothing may be left to guesswork. Nothing is.

A turnkey job may require up to $200,000 worth of equipment and supplies, including instruments, vehicles, camp facilities, etc. All equipment and supplies used in foreign operations usually are shipped by boat, save for lightweight instruments which may go by air freight.

That, of course, involves export application within specific terms of complex restrictions. Equipment purchased by the Dallas office is fully tested at GSI's Grapevine testing ground 15 miles northwest of Dallas.

Then it must be reboxed. Packing lists are prepared for the forwarding agent at the selected U. S. port showing value, gross weight, dimensions, etc., of all contents of all boxes.

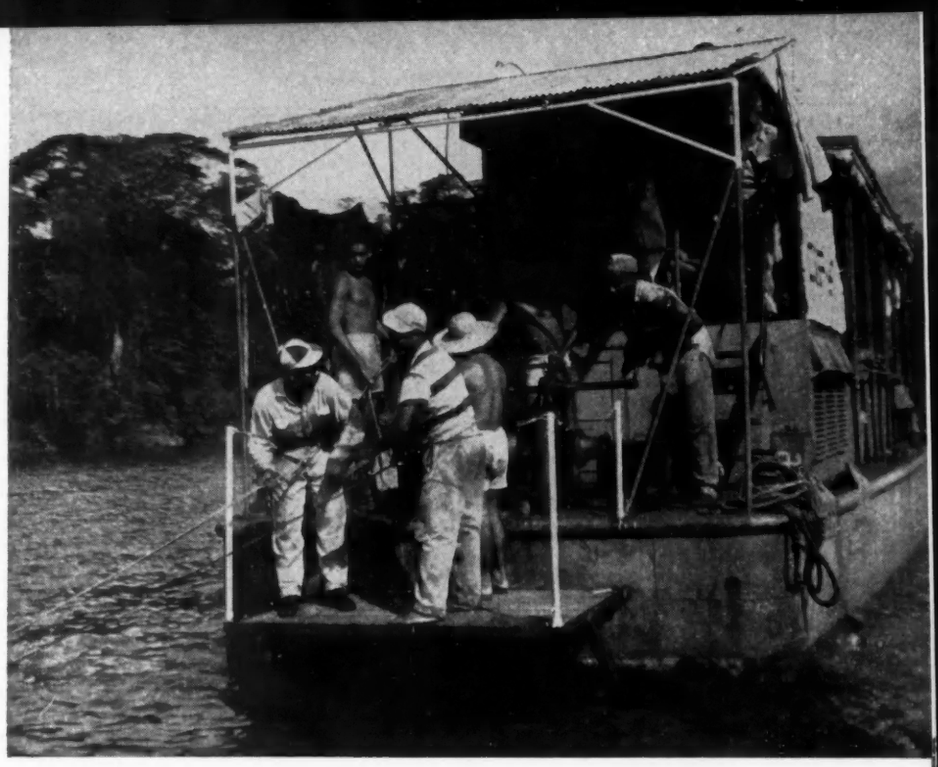
How well equipment must be packed is illustrated by one of GSI's wartime experiences. In 1942 a GSI party chief left Sumatra barely ahead of advancing Japanese. He was forced to leave behind on a dock a box of seismic instruments.

Upon his return to the U. S., a claim was filed with the State Depart-

ment on the loss, as the U. S. government had requested.

No further thought was given the box of instruments until 1948. It was then that GSI was notified that a box bearing the company's Dallas address was enroute from Sumatra.

Of course, upon arrival the box was found to contain the seismic instruments left behind six years earlier. But a close check revealed that the packing job had lasted six years—the watertight container and drying agents had done their jobs. With new batteries, the equipment was tested and found perfect. It was put back into the field immediately.



Geophysical Service Inc. Photo

THIS CREW is preparing for shooting operation in Brazil's Amazon waters.

Personnel phase of overseas operation. When all equipment and supplies are sent to the forwarding agent at the U. S. port of departure, one phase of the preparation is completed.

Meanwhile, another phase—and perhaps the most important of the undertaking—has been functioning smoothly through the Personnel department.

To staff a field party, highly-trained personnel must be available. Their selection is not automatic. Instead, careful screening of prospective company personnel is emphasized.

GSI's Personnel department maintains a continuous check on recruiting, training and placement. For foreign work, a ready pool is kept up to date on administrative and technical men who have indicated their interest in assignments abroad. During initial negotiations, a prospective client is given a tentative manpower resume. On the awarding of the contract, close liaison with the client results in selection of technicians based on location of the job, living conditions and logistics.

Once selected, staff members, together with families of the married men, are called in to Dallas to undergo detailed orientation and processing. This calls for a several-day schedule full of details, including:

1. Comprehensive physical examination for each party member and family.
2. Inoculations.
3. Passport requests.
4. Preparation of credentials for entrance visas.
5. Legal assistance. Company attorneys are made available to party personnel to draw up wills, powers of attorney, etc., and to handle any other legal matters requiring attention.
6. Orientation. Party personnel are familiarized with the type of exploration they will undertake, the country in which they will operate, its currency, laws, housing facilities, clothing and household furnishings which it has available, etc.
7. Arrangements for air travel.
8. Notification of draft board, if any members are eligible.
9. Boxing of party members' household belongings, depending upon the type of job. Again, the Equipment department must be furnished with detailed packing lists covering every box.

Geophysical Service Inc. Photo

FIELD PARTY CARAVAN with air-conditioned trailers to serve as offices, homes, laboratories, and kitchens heads into Saudi Arabian desert.

Overseas jobs benefits. Party members in countries outside the U. S. are rotated every two years and accrue vacation time at an accelerated rate. Often, a long-term overseas contract is set up so that personnel may be rotated home for a vacation after a two-

Continued on Page 148

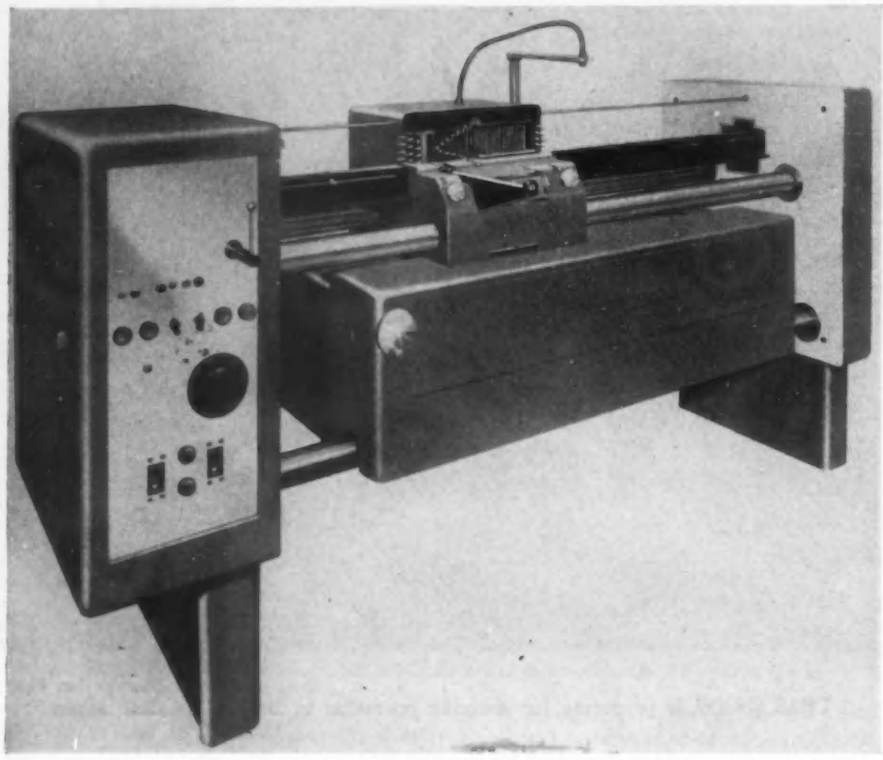


Photo Courtesy Reynolds Southwestern Corporation

Fig. 1—The Reynolds Model II Seismic Cross-section Plotter.

New Computing Device Aids Seismic Interpretations

Automatic plotter corrects for variables, plots all traces quickly and accurately.

THE REYNOLDS seismic cross-section plotter is designed to speed the translation of information of seismic records to useable subsurface data and to improve the accuracy of seismic record interpretation. This new device performs many of the more tedious computing operations automatically and permits interpreting personnel to devote full attention to final interpretation.

The plotter completes identification of reflected events (picking), counts time values of the picked events (timing), corrects these values for variables (computing) and plots event depths on a graph representing an earth cross-section. These operations are performed with no culmative error and within a fraction of the time required by manual computations.

In order to describe the operation of the plotter, it is first necessary to discuss, in broad terms, the present method of interpreting seismic records. A seismic record is a time-chart showing time required for a shock wave to travel from the earth's surface to a sub-surface bed and back to the surface. This shock wave usually is generated by an explosion at or just beneath the surface. Electronic instruments are used to produce a record.

Shock waves reflected by strata beneath the surface are translated into electrical signals by geophones on the surface located at various distances from the shot point. The seismograph produces a photographic record on which the returning shock waves are portrayed by the wave form of the lines, or "traces." Each trace represents a geophone station.

When several traces exhibit a similar wave form at approximately the same point on the record, the wave forms are usually assumed to represent a reflected wave, or "event." The vertical lines on the record are used to relate the travel time of the event to the instant at which the shot was detonated.

This travel time is used to determine the depth to each bed which reflects the shock wave. The depths are determined at several points along a traverse and are plotted on graph paper. When these points are connected, the graph is referred to as a cross-section. Ideally, the cross-section portrays the attitude of the sub-surface beds with respect to an arbitrarily selected datum plane at or near the surface, thus enabling a geologist to study the structure of the beds.

Complicating factors. In practice, this process is complicated by several factors. The seismic instruments portray the information on photographic records by means of a beam of light which moves laterally across the paper in answer to electrical signals from geophones. An envelope, which is a derivative of the wave form arriving at the surface, is produced. There is one beam, or trace, for each geophone station.

However, since the geophone stations are at different distances from the shot point, a reflection from a level bed, for example, will appear at different time-positions on each trace. The geophysicist, identifying reflections from the mass of data on each record, must allow for this displacement as well as for differences in elevation at each of the recording stations. These factors affect the apparent time

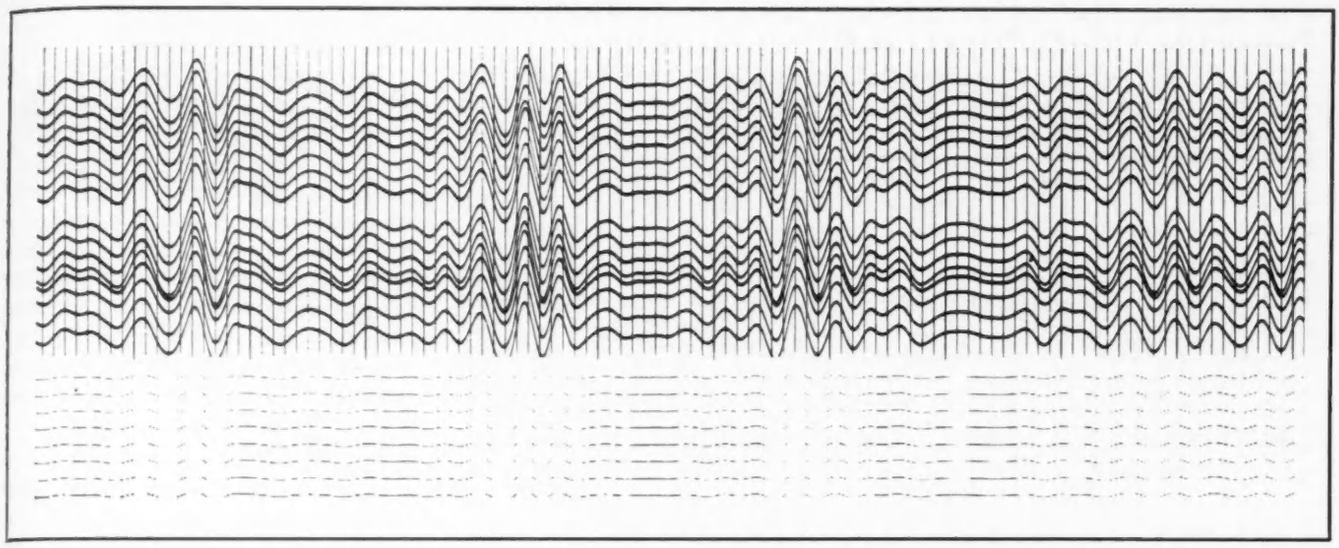


Fig. 2—Conventional seismic record at top, with corresponding Reynolds "point-plot" record at bottom.

of arrival of the event at each station. Velocity differences caused by variations in the weathered layer also must be carefully considered.

This laborious process of picking, well known to every geophysicist, is very time consuming and relies, to a great extent, on the experience of the geophysicist and his ability to interpolate all of the factors involved.

As a result, times usually are assigned to no more than four of the traces. Other traces are observed only to indicate the phase relationship of disturbances arriving at the geophone stations. Those which approach being in phase at the various stations (the above variables being taken into account) are usually assumed to be reflections. Naturally, the interpreting operation tends to be conservative under these conditions, and as a general rule, only the most salient reflections are timed.

The times from the traces used are corrected for the effect of these variables; the corrected times are changed to equivalent depths; and the depths at each shot-point are plotted on the cross-section. These operations require considerable time and a great deal of study on the part of the interpreter.

How it works. The Reynolds seismic cross-section plotter uses photographic, optical and mechanical processes to complete all of these steps automatically. The plotter examines each trace on a series of seismic records and

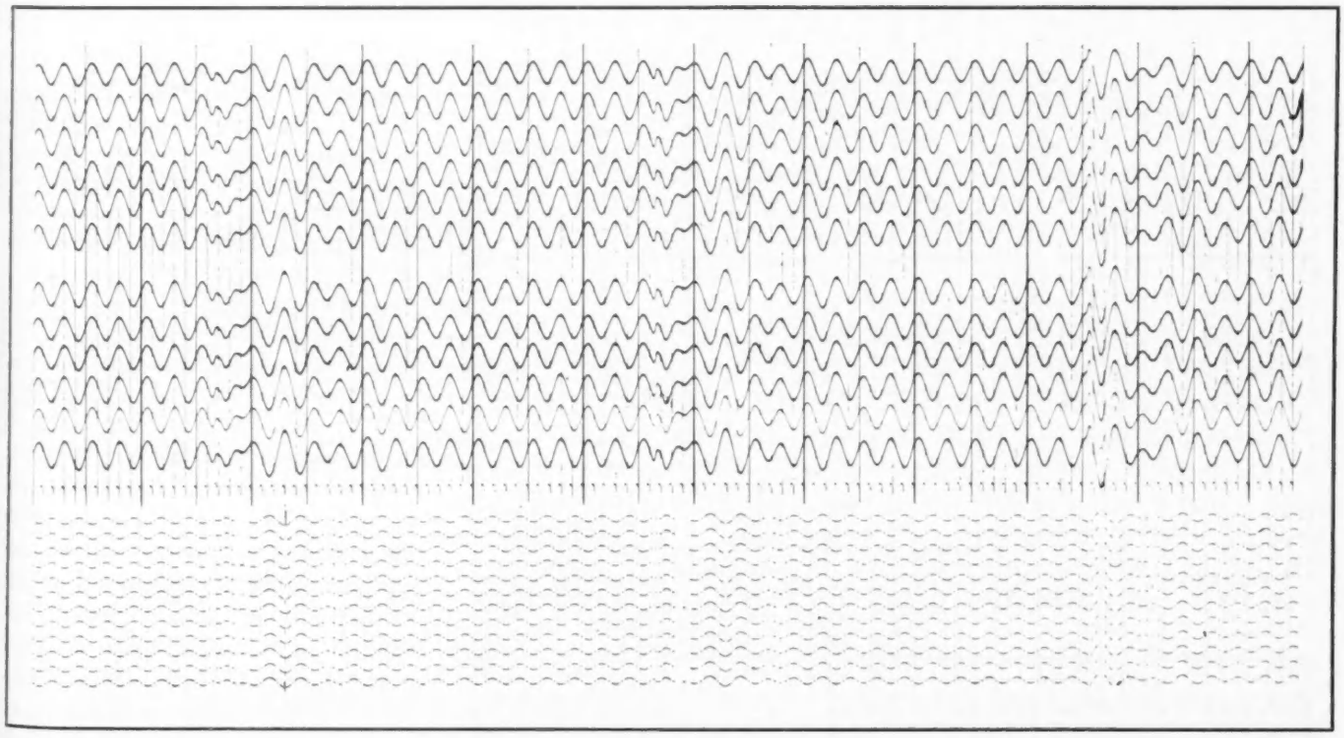


Fig. 3—Conventional seismic record at top, showing corresponding Reynolds "point-plot" at bottom. The lower plot has been modified to show more of the wave envelope.

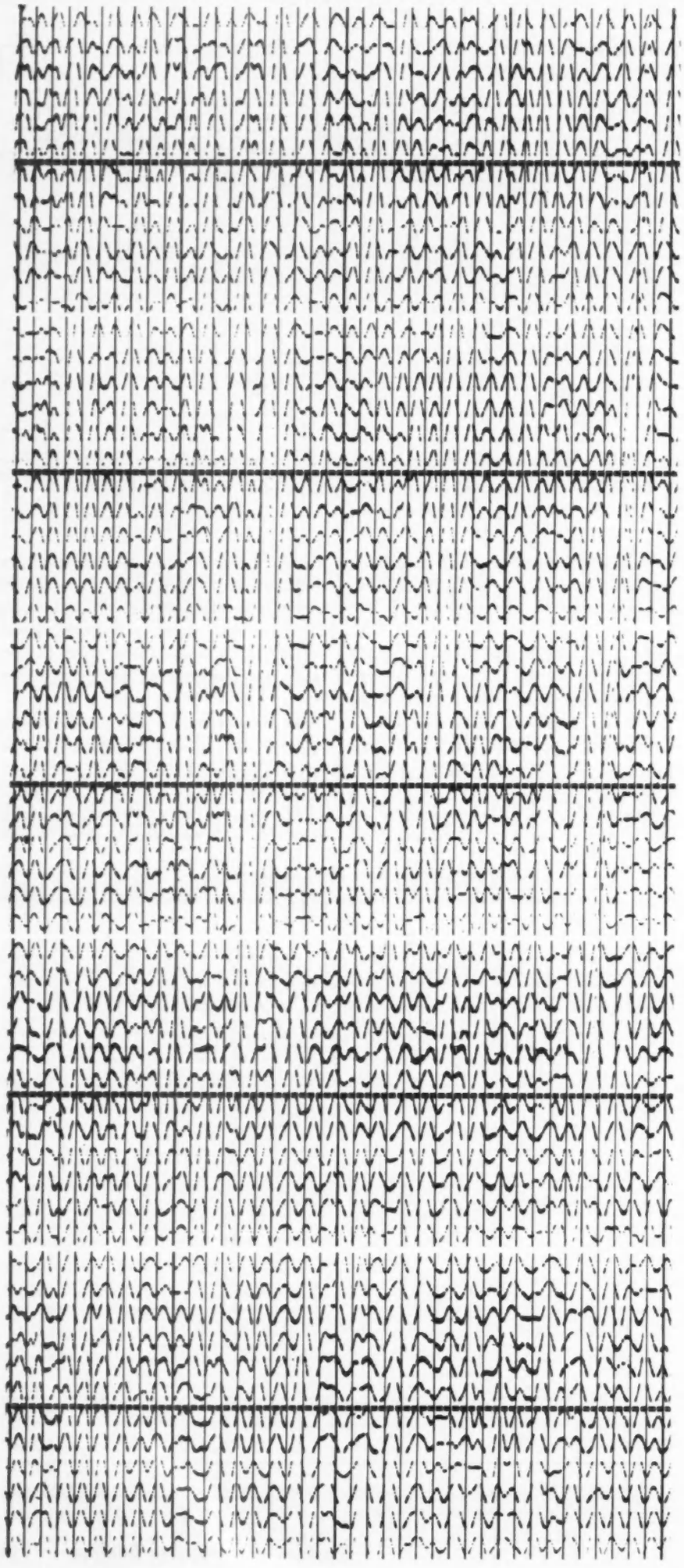


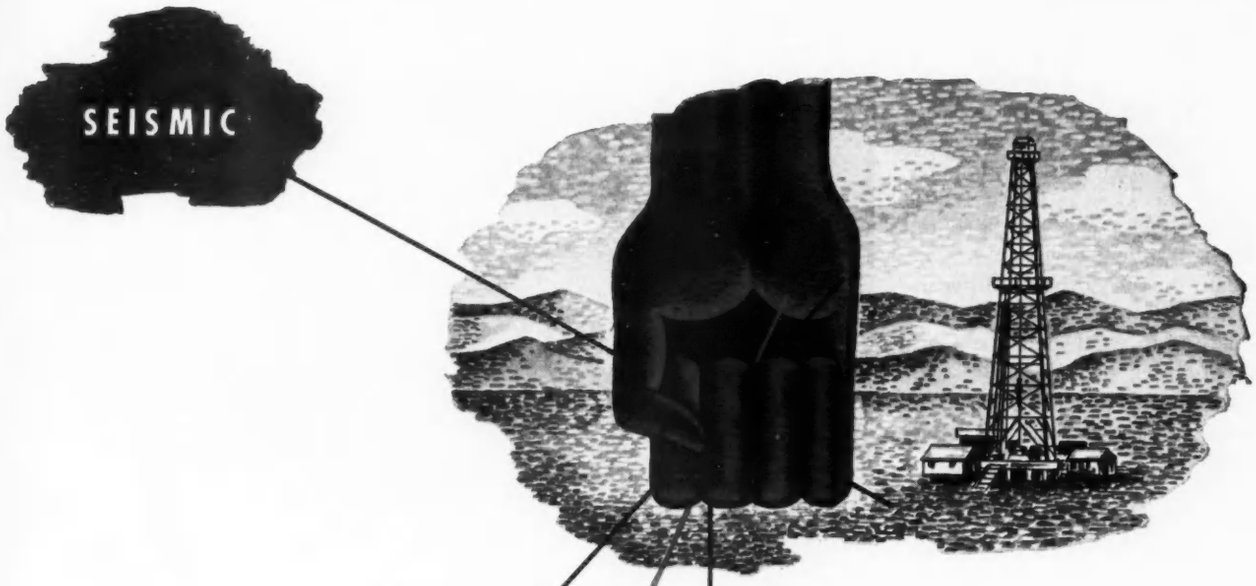
Fig. 4—Segment of a cross-section made by Reynolds plotter from seismic records taken in Gulf Coast area.

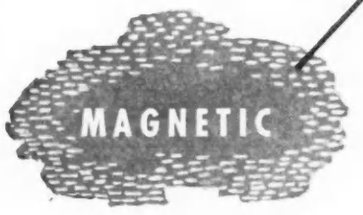
notes the phase relation of events appearing on each trace to produce a corrected, depth-plotted cross-section on photographic paper. Each trace on the record is portrayed on the cross-section, and each has been corrected for such variables as step-out, weathering and velocity. As many as 400 records may be plotted on one cross-section, thus furnishing continuous sub-surface information.

Special seismic records which portray information from every other geophone station are used with the plotter system. A conventional seismic oscillograph is modified to produce these special records. An optical amplitude reducing lens reduces trace displacement to a point where none of the traces cross to permit individual scanning of each trace. The lens also increases the density of the traces, so that variations in developing in the field will not interfere with the operation of the plotter.

A screen introduced between the trace light and the recording paper allows passage of the recording light beam through an opening coinciding with zero image amplitude. This opening allows a point to be plotted each time the trace is displaced by a geophone signal, and each of these points is an automatic time-plot, or reading, of ground motion. The opaque shield (the screen) on each side of the "zero" position of the trace tends to minimize the recording of lower amplitude information with respect to the larger wave outlines. Thus the masking system tends to emphasize the more significant reflections. The point-plots recorded in this manner constitute a portion of a plotted "raw" (uncorrected times) cross-section.

Film negatives are made of each of the point-plotted records. A high contrast emulsion is used to bring all of the records to a relatively uniform contrast level, and two additional traces are recorded. One of these traces represents a portion of the timing lines on the original record so that variations in camera speed and changes in record length resulting from temperature or humidity conditions may be compensated. The other trace controls individual trace alignment during the scanning operations





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which follow. The film negative is used to record photographically the finished cross-section. A moving light source scans each trace along the length of the film strip which has been positioned over the cross-section recording paper. This light source is adjusted to move at a rate proportional to the applicable variables. The cross-section paper moves differentially as a function of the relationship of record time to earth velocity. Controls are provided to adjust the scanning of each trace to compensate for the weathering, step-out and elevation corrections applicable to the geophone station corresponding to that trace. As the image of each trace is recorded on the cross-section paper, it is automatically placed in its proper relation to the datum plane, with the effects of step-out and weathering variations corrected.

The scanning operation and the movement of the cross-section paper changes time (a function of length on the original record) to the equivalent depth for each trace. Thus, the information has been picked, timed, computed and plotted, and is ready for study. Approximately one minute is required to transfer all of the information on one record to the cross-section. Mathematical computation and the corresponding opportunities for error are eliminated.

Finished cross-section. The finished cross-section is ready for study by the interpreter, who draws horizons, using every trace that shows pertinent information. Picking does not begin or end at a given shot point, but proceeds along the traverse, making full use of the information provided by each trace. The interpreter is free to make his decisions without attempting to render the corrections applicable to each trace and without interpolating "raw" trace times.

Use of the machine results in a drastic saving of time required for interpretation. It eliminates "human error" in computing, and much information previously neglected is brought to bear on final interpretation.—**The End**

ACKNOWLEDGMENT

Material for this article was supplied by the Southwest Industrial Electronics Company of Houston, Texas, who manufacture these automatic plotters for the Reynolds Southwestern Corporation.

Geophysical Service Inc. Photo

TWO WATER TANKERS (drill tenders) and three combination air-water drills are assembled at GSI's Dallas headquarters prior to overland shipment to West Coast thence to western Australia.

Geophysical Contracting Abroad

Continued from Page 141

year stint and then returned to the same assignment, if they so desire.

And it is not unusual for a single party to operate afield much longer than that. One GSI party has been operating along the upper reaches of Brazil's Amazon river for nine years. It is a mobile party consisting of bunk barges, mess barge, hospital barge and repair barge.

GSI's policy of training local people to staff field parties whenever practicable is well illustrated by Party 621. All technical men on this party are Canadians, but the party is currently operating in India, where it employs Indian nationals as laborers and helpers. A GSI field party in Mexico is staffed 100 percent by Mexicans. Another party, which soon will be operating in Sumatra, will be composed of nine American technicians and will employ about 500 nationals as packers, laborers and helpers.

Geophysical contractors make every effort to satisfy the needs of field parties in remote regions. GSI offers its technicians a voluntary, company-paid and company-prepared correspondence training course in seismic theory and practice. Entrance exams are supervised by the Seismic Engineering department, which also conducts the course.

Seismological experts developed this technical course, and each foreign crew is equipped with reading references, study materials, sample problems and lesson assignments.

This program bespeaks a need for a library. And GSI supplies one for each overseas party, too.

Upon satisfactory completion of the course, the student receives a formal certificate of completion. The course has attracted such interest that frequent inquiries are received from technicians outside GSI. Within the organization, the records speak for themselves: Eighty-four crew members are enrolled currently; the number of course completions stands at 165.

This program is just a part of the organization's constant effort to improve the lot of its personnel abroad. What success the over-all effort has achieved is pointed to with justifiable satisfaction: less than .5 percent of its contracts with crew members have gone unfulfilled. —**The End**

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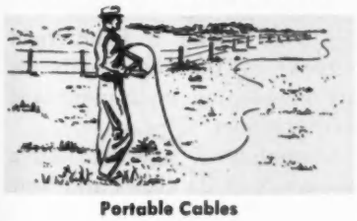
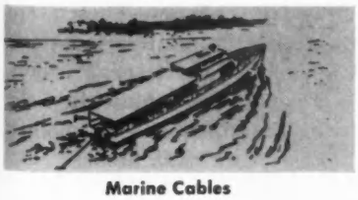


Portable Cables

Bay Cables



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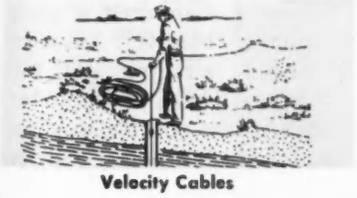

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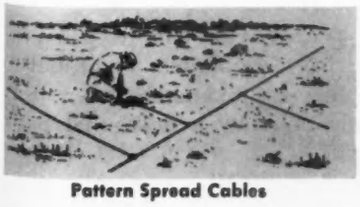

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SETTING CHARGE in air shooting pattern near High River, Alberta, Canada.

Air Shooting Useful As Reconnaissance Tool

Poulter method in seismograph work is found desirable in high velocity sediments and sparsely settled areas of West Texas and Western Canada but less suitable for the soft sediments of the Gulf Coast.

By LEON V. MANRY, Geological Consultant, Houston, and **WILLIAM SAX,** Geophysicist, Houston

A SPECIAL GEOPHYSICAL exploration program was conducted during a recent period, and a number of geophysical methods were used. Testing of over 30 prospects was accomplished within 12 months. The areas covered were in the Gulf Coast, West Texas, and Western Canada.

Purpose of program. The primary purpose of the program was to check the areas rapidly and with a minimum of cost. Because of the time limitation, decision was reached to check non-geological or geophysical data by running only key lines, such as dip lines to establish reversal or faulting and strike lines to determine closure. Thus a few profiles could be run in each area, giving a fast, inexpensive check of a prospect without having to detail the area.

Selection of air shooting. Selection of air shooting as a part of the program was made after discussion of the method with a geophysical company that has used the Poulter method for some six years. Limitations of air shooting such as the necessity of long offsets in low velocity areas, psychological effects of the noise, and other disadvantages in populated areas were all considered. The Poulter method, according to our information, had previously not been used in the soft sediment country of the Gulf Coast, and since several of the prospects to be tested were in this area, comparison of air shooting with hole shooting would be made.

Equipment used. Light, portable recording instruments were selected, and these were mounted in a light-panel truck. In some instances, they were transported in an ordinary passenger car. A 12-trace, 24-channel recording instrument was used throughout the program. The usual procedure was to use mixing for one-half of the record, with the other portion unmixed. Suitable accommodations were provided for storage of detectors, cable, etc., including a light, tight compartment in the rear, with the necessary developing equipment and spare-parts cabinet.

The seismometers selected had a basic frequency of 25 cycles and were designed for minimum weight combined with high output and equipped with tubular spike bases. These were usually coupled in multiples of four or eight geophones per trace. Portable radios were used throughout the field work for communications of shooter to observer and for time breaks.

Seismic crew. Crew members used during this work comprised a party chief-interpreter, observer, shooter, shooter's helper, surveyor and two utility crewmen. Using this number of personnel, it was possible to cover from eight to ten shot points daily or an equivalent of two miles of continuous profile per day.

Field procedure. The explosive charges were mounted on tubular steel stakes approximately seven feet in height. Usually a hexagonal pat-

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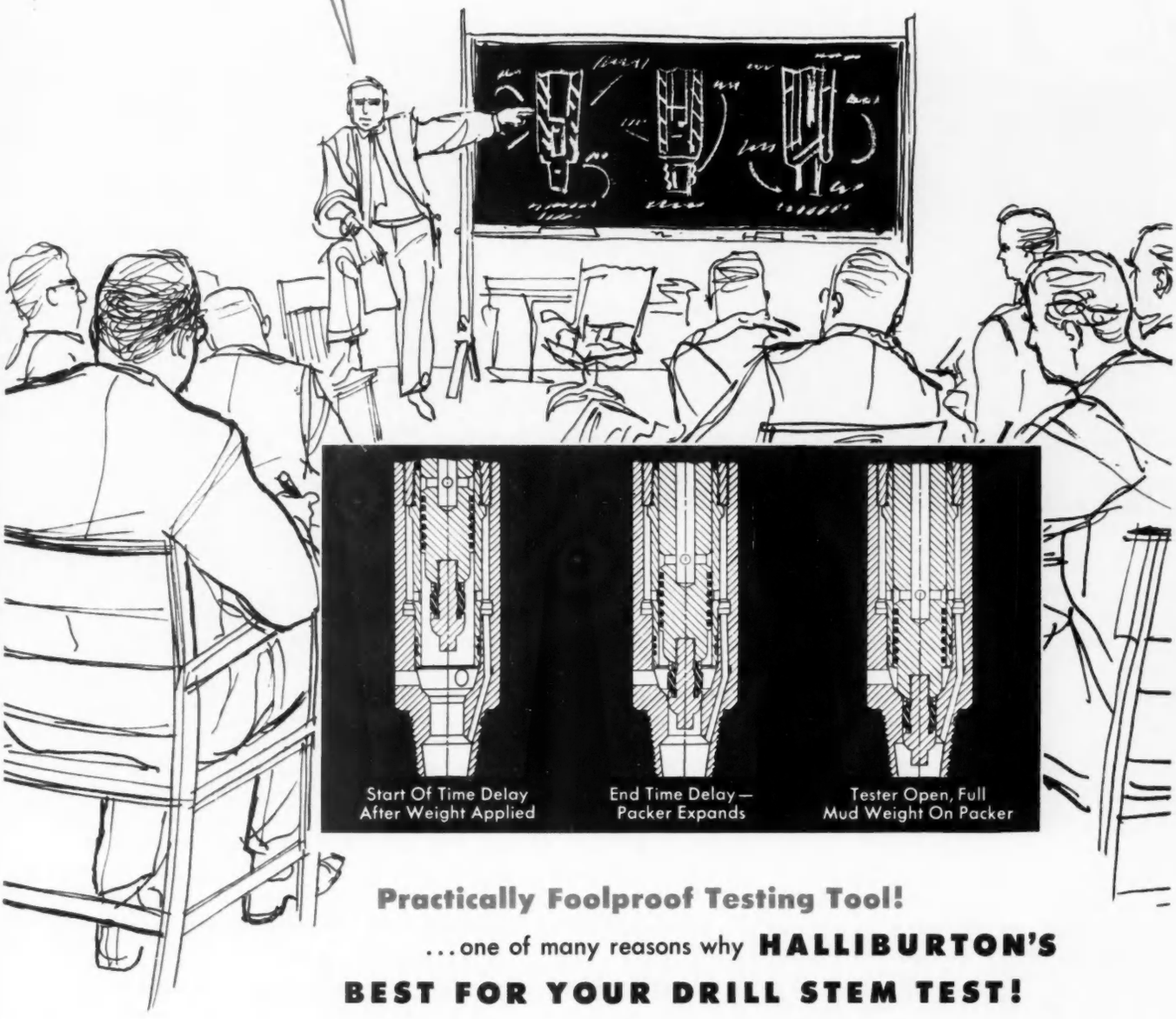

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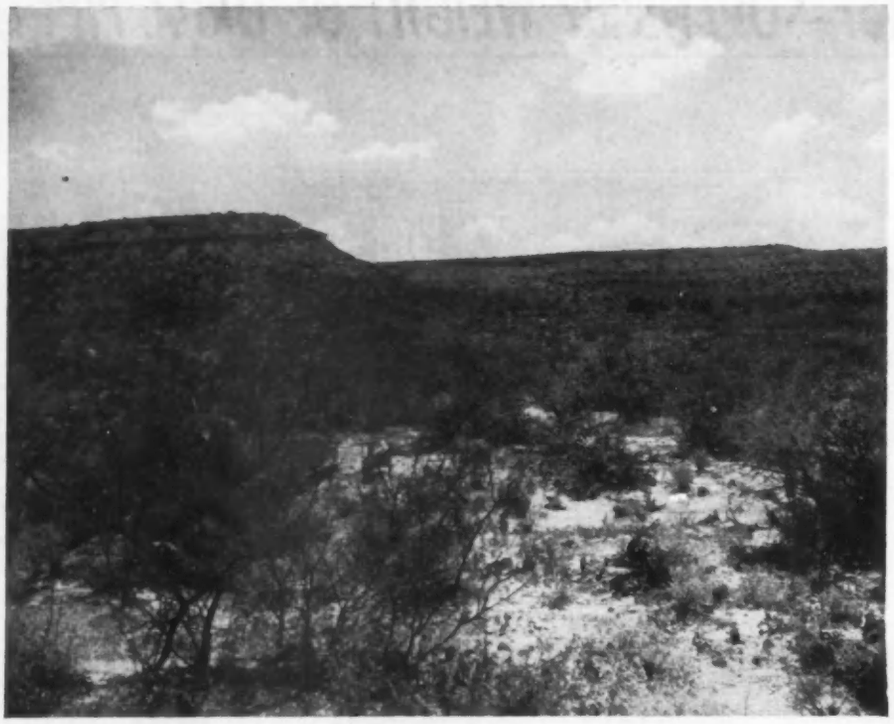


TYPICAL WEST TEXAS TERRAIN covered by air shooting.

tern of seven charges with a total of 20 pounds of high-velocity dynamite was used, with spacing varying between 30 and 70 feet. In some cases, the total charge was increased to 35 pounds. In West Texas, in some instances, it was necessary to employ 13 charges with either 2½-pound or 5-pound charges on each stake.

In a new area, the predominant frequency was determined by first taking a trial shot with 50-foot spacing, using a broad filter setting. From this record, the optimum frequency could be selected and additional test shots taken at that frequency to determine the correct filter setting and desired amount of explosives.

Prospects covered. During nine months of operation, some 12 prospects were covered by the use of air-shooting. On seven of these prospects air-shooting was found to be satisfactory. On the other five prospects, due to difficulties of populated areas, shallow water-tables, and other factors adverse to use of the Poulter method, it was necessary to employ shot holes; however, on only two prospects was the shot-hole technique used exclusively. In all fairness, it should be pointed out that ten of the prospects covered were in the Gulf Coast area; with only two areas in West Texas worked. It is believed that the percentage of effective air shooting would be considerably higher if the majority of the exploration work had been done in West Texas.

Experimental work in Canada. Two areas in Alberta Province, Canada, were tested experimentally with air shooting. In one of these areas, approximately 100 feet of glacial fill made shot-hole drilling slow and expensive, and records taken in the conventional manner contained practically no usable information. While the air-shot records employed about 60 percent more dynamite, the events on them were considered to be of from fair to good quality.

Conclusion. The reconnaissance shooting method in checking geological prospects is quite good when the area is fairly well defined; but when the area is large, the shooting then becomes a normal pattern for the search of a prospect. For general reconnaissance shooting across a large area, air shooting had certain inherent advantages.

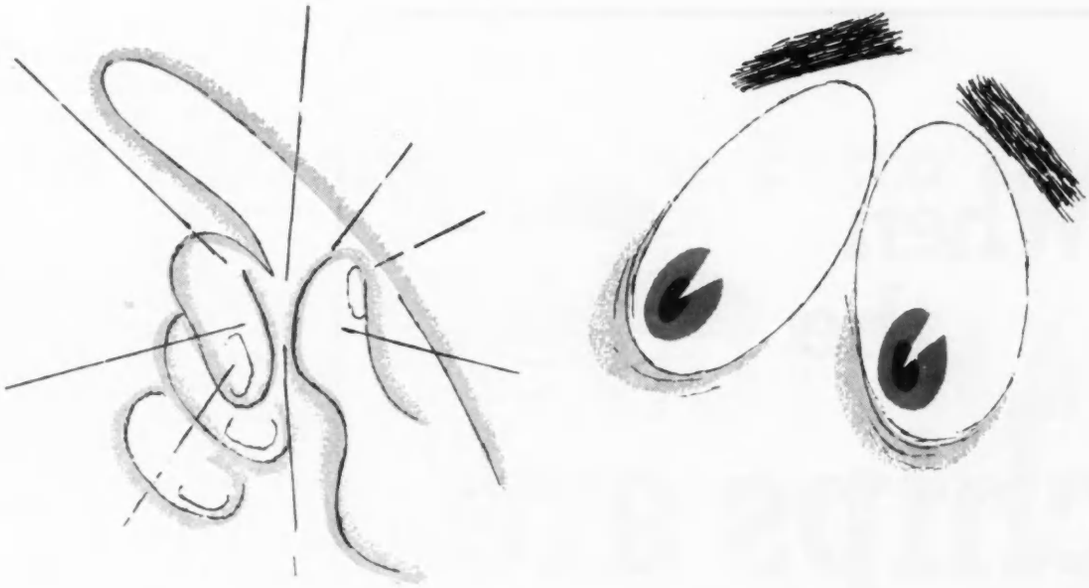
In general, experience has shown that the advantages of air shooting are most apparent in the Pre-Mesozoic formations of West Texas, and it was possible to verify that in these areas the Poulter method gives increased signal-to-noise ratio, absence of multiple reflections, and a resulting improvement in record quality. In the more recent formations of the Gulf Coast area, no economic advantages were secured, and on two prospects where a shallow water-table was encountered, hole-shooting was used as the preferential method.

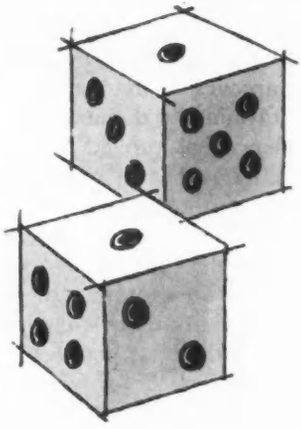
Use of air shooting in low velocity formations requires too great an offset for workable results. With an excessive offset, the stepout on the seismogram is so large at shallow depths that continuous reflections are hard to distinguish. Moreover, more dynamite is needed for air shooting in the

About the Authors

LEON V. MANRY, JR., has been manager of Geotek Oil Company, Houston, since January 1953. He previously worked for Frio Petroleum Company, Ltd., from 1949 to 1953. Manry was graduated from Rice Institute in 1948 with a B.S. degree in E. E., and subsequently did graduate work at Rice. He also did graduate work in geology and petroleum engineering at Texas A. & M. College and at the University of Houston.

WILLIAM A. SAX was graduated from St. Louis University Institute of Technology in 1950 with a B.S. degree in exploration geophysics. He worked for Seismic Explorations Inc. on a seismograph crew over a year and a half. He then worked for Forest Oil Corporation a year in Midland doing interpretation. Following this, he worked as a party chief eight months with Superior Exploration Company using the Poulter method.





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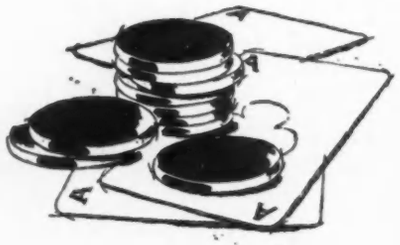
When the  chips are down

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soft sediment areas. A definite conculsion was reached that hole shooting in the Gulf Coast region yielded superior quality records.

On the other hand, advantages of air shooting are quite clear in West Texas and Western Canada. Air shooting is more portable, due to the absence of drill and water truck, and hence is much easier to use in rough terrain. Weathering was computed by refraction and compared in accuracy to the up-hole method of hole-shooting.

One distinct advantage of air shooting relates to the repetition of a record when found necessary due to poor developing, camera motor trouble, no time break, etc. Two records shot with the same filter, shooting pattern, and amount of charge will be duplicated down to the most extraneous oscillation of the galvanometer.

While there are psychological disadvantages in the use of air shooting in farming and ranching areas, experience has proved that proper orientation of nearby residents forewarns them of the louder noice, and little difficulty was experienced in convincing these people that no harm would result to the ground surface or nearby livestock. Actually, air shooting produces little or no damage with respect to water wells. Livestock are not frightened, and there was no instance of cattle or sheep running after the explosion.

In order to decrease the shock wave and noise of the air explosion, shallow hole patterns were attempted in some areas. Holes of varying depth from one foot to six feet were used in a pattern arrangement. However, the surface damage was so great, the flying debris so dangerous, and the over-all records quality so poor, that this method was abandoned.

The general conclusions are that the Poulter method is a very useful and relatively inexpensive tool in high velocity sediments and less densely populated areas. Air shooting is not recommended for the soft sediments of the Gulf Coast.

ACKNOWLEDGMENT

This independent and impartial evaluation of the air-shooting method was developed at the instance of the Institute of Inventive Research and Southwest Research Institute, San Antonio, Texas. The report was written at the request of the institute, and is a factual presentation of the method's disadvantages, under certain conditions, as well as its advantages.

—The End

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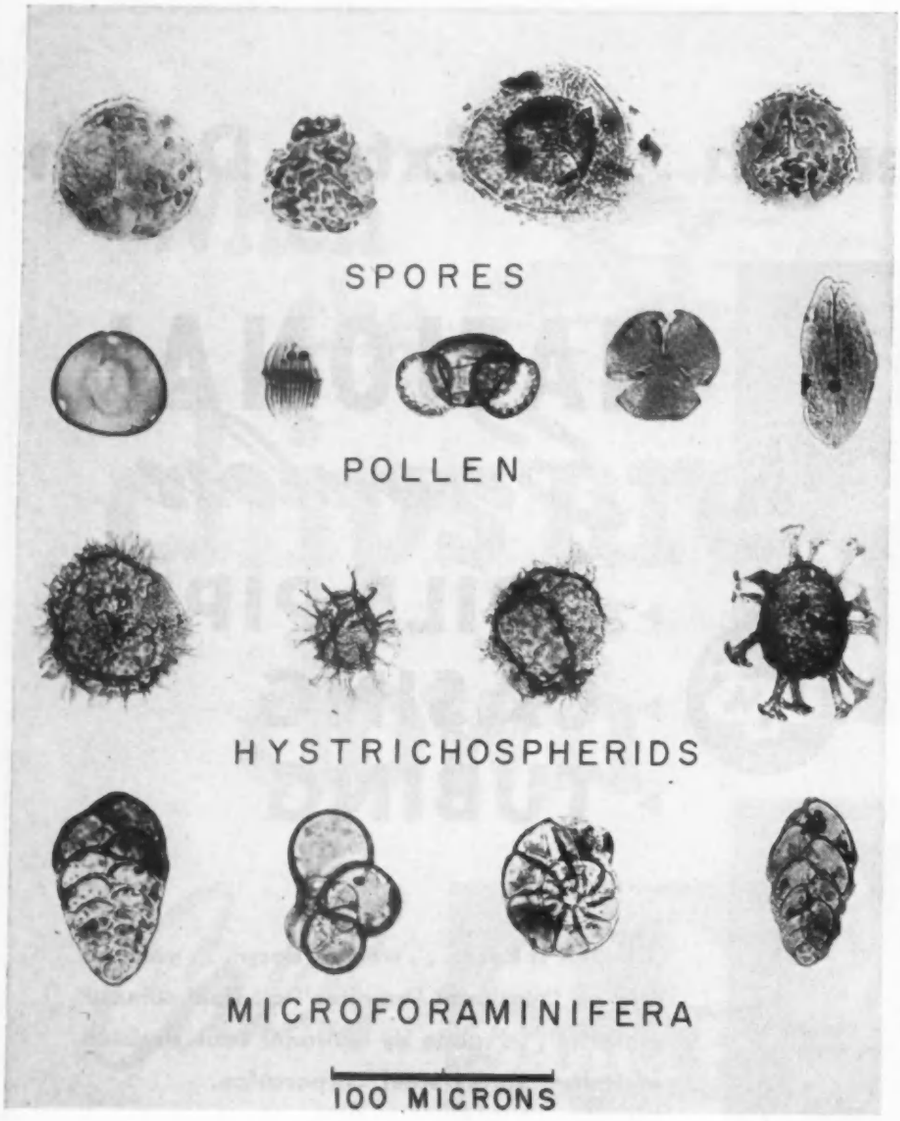

Typical Microfossils

Microfossils Provide New Technique in Exploration

Miniature plant spores and pollen and minute animals found in sediments can be used for (1) age determination (2) zoning formations and (3) indicating favorable environment of deposition.

By DR. WILLIAM S. HOFFMEISTER, Senior Research Geologist, The Carter Oil Company Research Laboratory, Tulsa

THE USE OF PLANT spores and pollen in oil exploration is new to the oil company paleontologist. Only recently some of the oil companies have discovered their value and in some cases paleobotanists are being added to the paleontological staffs.

The most common microfossils used in the search for oil are the plant spores and pollen and the animal hystrichospherids and microforaminifera. All four groups of these minute fossils are found in the same prepared residue so that no particular method for extracting any one group is required. Although other microfossils are being used in oil exploration work, such as dinoflagellates and discoasterids, because of their relatively rare occurrences, they will not be included in this discussion. The size range of these new fossils ranges from 10 to 150 microns and they are therefore only capable of being studied under a powerful biological microscope.

Plant spores have been observed in coal as early as 1833. At that time Witham described them from bituminous coals in England. Since then workers have used them for the recognition and correlation of coal seams both here and abroad. The Illinois and other state geological surveys have done extensive work in this country on fossil spores for coal correlation in the Paleozoic rocks. At present the Oklahoma State Geological Survey is sponsoring spore studies of some Paleozoic coals for the purpose of acquiring data for the recognition of each particular coal seam in the state. Plant spores have been found in this country in rocks as old as Devonian, while abroad they have been reported from sediments of Cambrian age. In Australia workers have recognized them in rocks of Silurian age.

Spores and pollen. Spores are the reproductive bodies of the non-flowering plants while pollen are the male reproductive bodies of the flowering plants. Morphologically spores are characterized by the presence of sutures, and pollen by the presence of furrows and pores. These sutures, furrows and pores are associated with the germination process and act as openings through which the plant reproductive cells escape. Although the earliest known flowering plants are known to have existed during the Triassic system, the oldest known pollen grains are found in the overlying Jurassic sediments. Not as much information on pollen is available as that on spores owing to the extensive studies by early workers on Paleozoic spores in coal.

Hystrichospherids generally are spherical bodies with spines. These mi-

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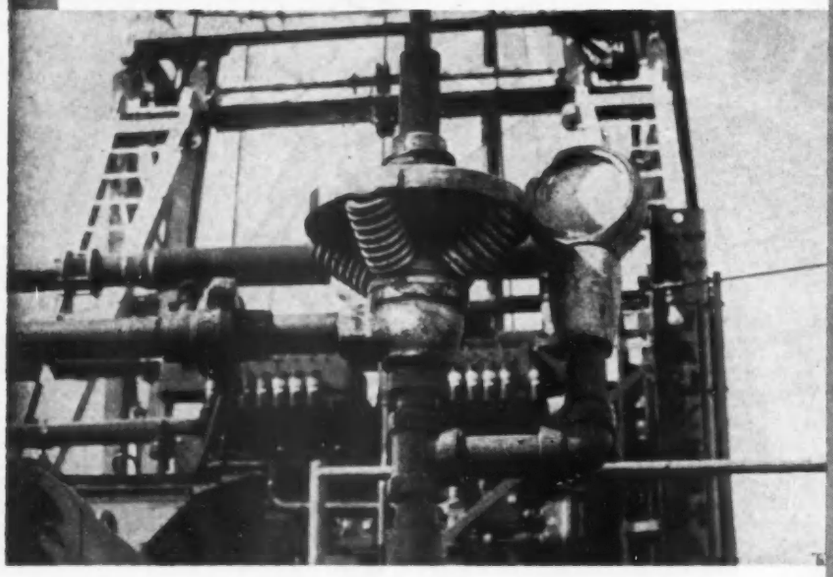

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nute animals are found in rocks of Pre-Cambrian age to Recent. Biologists who have observed them in the present oceans are at a loss to assign them to any known group. As they are one-celled forms some workers believe they belong to the phylum protozoa and are closely allied to the dinoflagellates, while others believe they might be reproductive bodies of more complex animals such as the bryozoa. Early workers abroad thought they could possibly be winter eggs of some unknown animals. We find these small spined animals in various types of rocks, including limestones and cherts. The early Paleozoic forms generally are smooth, cyst-like types becoming very spiny in the Silurian and younger rocks, and seem to reach their greatest complexity during Mesozoic time. They are especially useful to the stratigrapher for early Paleozoic rocks where plant spores are rare or absent.

Microforaminifera are the minute megalospheric forms of foraminifera which have escaped the fine mesh screens in the oil company's paleontological laboratories and have recently been noted in studies of spores and pollen. Whereas foraminiferal studies have been confined by most workers in oil exploration work to forms ranging from 200 to 750 microns, the microforaminifera have size ranges from 50 to 150 microns. Foraminifera have calcareous or siliceous shells, yet their remains are encountered in residues prepared with hydrofluoric acid which should ordinarily destroy these coverings. It is believed that some have not only calcareous or siliceous outer shells but also acid resistant inner coats which protect their individual chambers.

In order to prepare samples for the study of microfossils as little as five grams of sediment (a heaping teaspoonful) is required. The material is placed in a copper beaker and covered with 52 percent hydrofluoric acid. This is kept under a hood for 16 hours. However, if a quick age determination or correlation is desired, which is frequently the case, the sample is boiled in the acid (under a hood) for five minutes instead of

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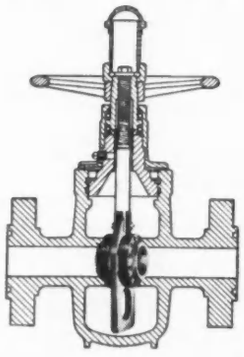

Positive dead-tight seal with pressure on either side of gate. Grove Seal-"O"-Ring Gate Valves also serve as a line blind.

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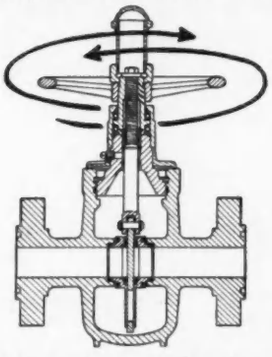
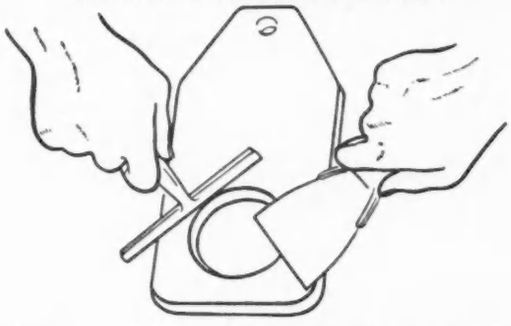


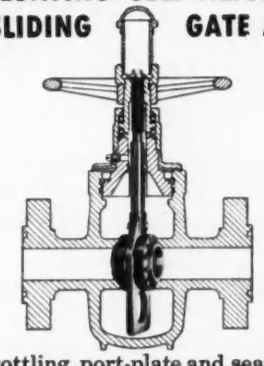
Parallel-sided full-opening port plate is non-wedging, non-galling, non-distorting. Torque required to open or close valve is less than other types of gate valves.

DUAL SELF-CLEANING ACTION



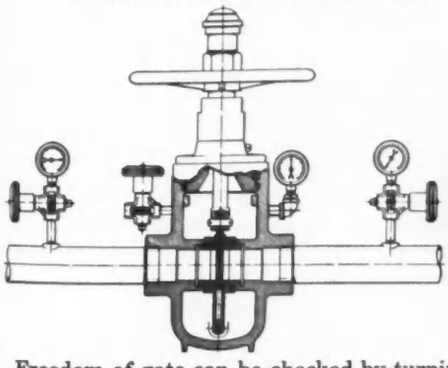
Steel seat assemblies and resilient "O" ring seals are in constant contact with full-opening port plate. Seating surfaces are stripped clean, squeegeed and polished with each operation.

FULL-FLOATING. SELF-ALIGNING FREE-SLIDING GATE ACTION

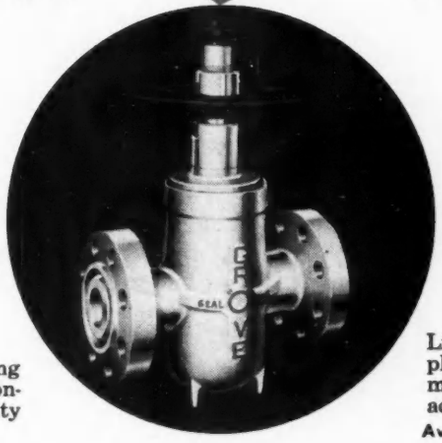


Open, closed or throttling, port-plate and seats are free-floating for perfect self-alignment, constant dead-tight seal, easy sliding action, imposing no strain or stress.

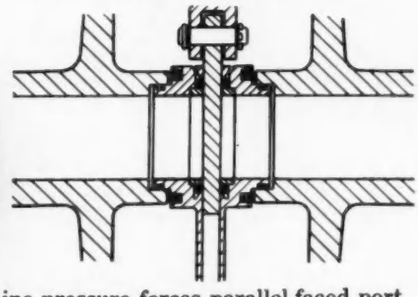
CHECK IT IN THE LINE—ANY TIME



Freedom of gate can be checked by turning hand-wheel, without "breaking" the seal. Non-variance of gauge pressure on body cavity verifies dead-tight seal of valve.



THE GREATER THE PRESSURE THE TIGHTER THE SEAL



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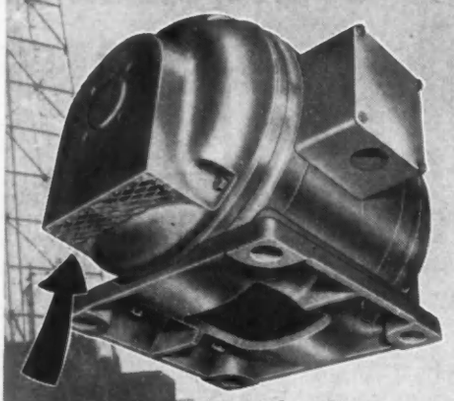

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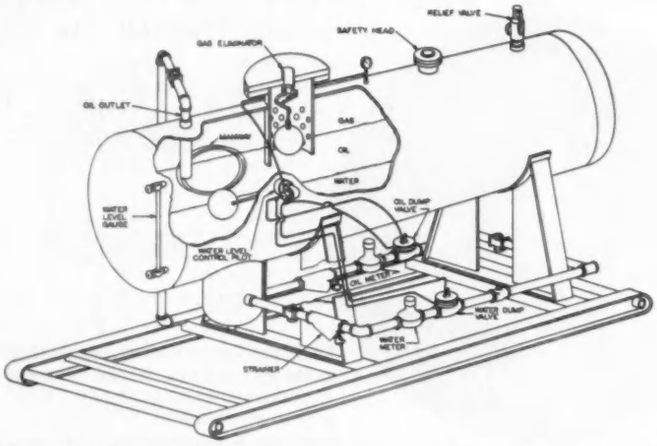

The Rolo Free Water Knockout is primarily an oil and water separator when water is the largest quantity and when air or gas is of minimum volume. No provision is made to measure gas.

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allowing it to remain in the cold acid for a longer period.

The material then is diluted with distilled water and centrifuged. The water is poured off and the residue is washed and centrifuged again. A few drops of a feak solution of safranine Y stain is then added to the residue, after which it is ready for wet mount examination. If microfossils are encountered, permanent slides are prepared with a mounting medium of glycerine jelly or diaphane. Microfossils thus discovered can be used for (1) age markers, (2) zonation of a formation, and (3) environment indicators. Deductions based on the environment of deposition may be used to separate the favorable areas from the unfavorable areas for oil exploration. These topics will be discussed briefly.

Percentage high. Of the thousands of samples examined, including all all types of sediments, about three-quarters have yielded microfossils. Of this number about half contained microfossils diagnostic for age determinations. In other words, over one-third of the material examined carried microfossils indicative of its age. No other group of known fossils has such potentialities for age determination. If a sample contains microfossils, an approximate age determination usually can be made within one hour after the material is received at the laboratory. The preparation of the sample requires approximately 20 minutes by the fast method and it takes from 1 to 40 minutes, depending on the abundance or scarcity of the microfossil assemblage, to identify these small forms under a powerful binocular biological microscope. Unlike the foraminifera which are subject to environmental changes but are generally found prolific in marine sediments, plant spores and pollen, being windborne, are encountered in all types of environment ranging from continental to marine, and therefore make excellent time markers.

Before age determination by microfossils could be applied to rocks of unknown ages, a study of the microfossil assemblages has to be made from strata of known ages. Microfossils found in sediments throughout the geologic column are being studied and photographs (800x) of the individuals are placed on control cards along with data pertaining to the age and

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geographical location, and remarks covering the shape, size and ornamentation of the microfossil.

In this manner control files have been developed so that quick reference can be made for comparison purposes. From this mass of data, charts can be made showing the stratigraphic ranges of the various genera of spores, pollen and hystrichospherids. In many cases new genera have to be erected and described. Although general age determinations can be made, especially in the Paleozoic rocks by using the charts showing generic stratigraphic ranges, it is necessary to recognize the species of these genera before age determinations can be applied to rocks of a definite formation or unit. It obviously will take many years of work by many laboratories before fossils from all known ages are recognized and described. As published articles by universities and oil companies build up a literature, the method will become more useful to everybody.

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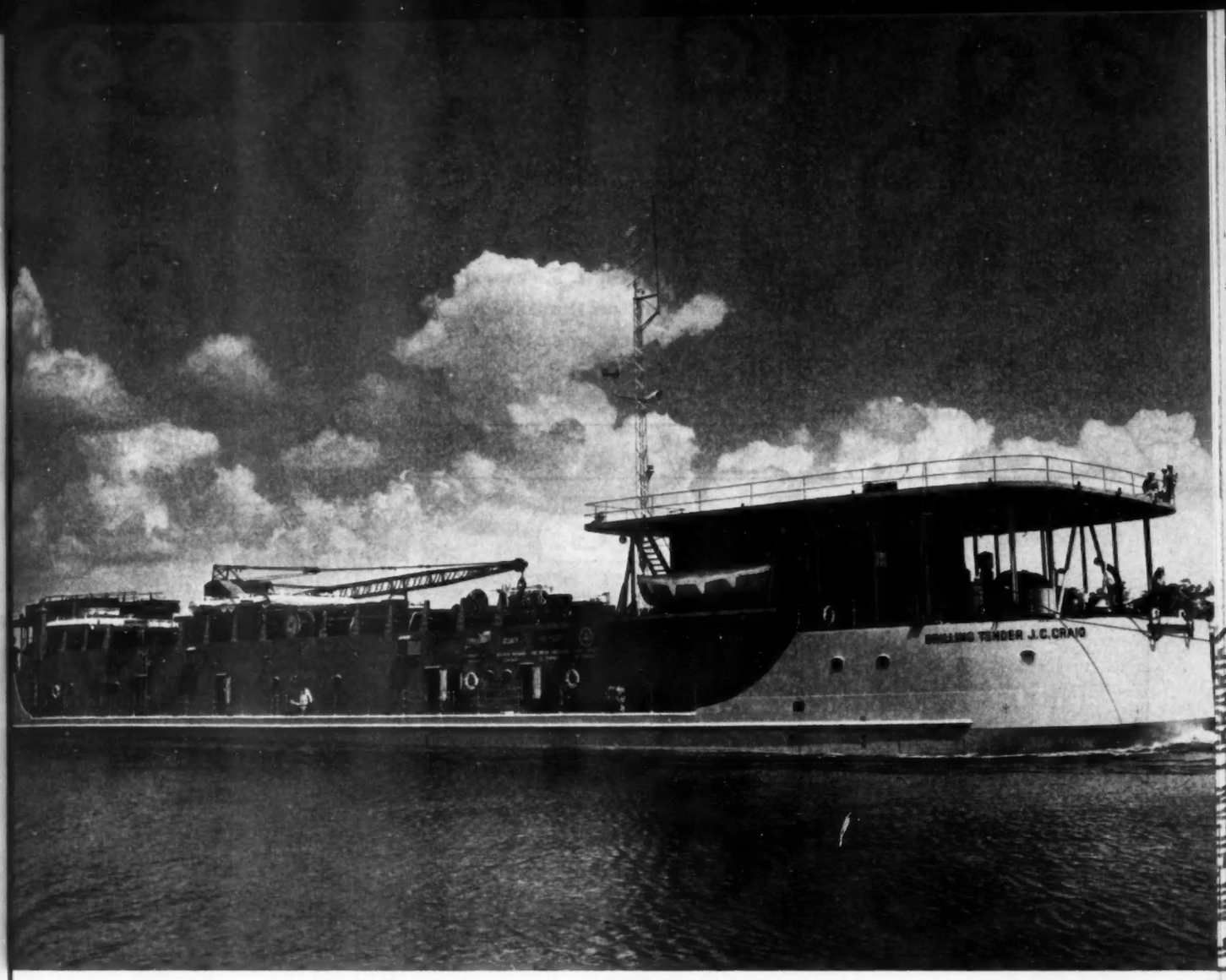
Three methods. In many cases it is desirable to zone a formation so that the oil geologist is afforded means for close correlation. With microfossils, zones are recognized by three methods: (1) the first occurrence of new forms, (2) population counts, which are a recording of the abundance percentages of genera or species, and (3) paleoecological interpretation, which makes use of the determination of the environment existing when certain sediments were deposited by the recognition of continental, near-shore and off-shore microfossil assemblages. For best results it is advisable to use all three methods.

As oil generally is found rimming an ancient basin and seldom in the center of the basin, it is important for the oil geologist to interpret the paleontological or ancient environmental conditions in the area being explored. Microfossils furnish excellent means for recognizing these environments. In general, the presence in a sample of only plant microfossils would indicate that it was deposited close to the ancient shore, a sample with mostly hystrichospherids would suggest a brackish to marine environment, and if the material contained mostly microforaminifera it would be inferred that it was deposited in an off-shore or marine environment.

By counting the number of microfossils in a group of boreholes from a particular sedimentation unit having the same geologic time, it is possible to determine the approximate location and direction of the shoreline. Study of bottom samples from off the Gulf of Mexico and off the Atlantic Ocean shore showed a decrease in plant microfossils away from the shore, an increase of the hystrichospherids in the brackish to marine environment and then a decrease, and a steady increase of the foraminifera seaward. The results of the studies off recent coasts can be applied to the ancient basins. "Isobotanical" contours are made on the abundance of spores and pollen per gram of sediment while "isozoological" contours are drawn on the abundance of hystrichospherids and foraminifera per gram of sample.



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These contours parallel the approximate position of the ancient shore. In a very broad sense, an abundance of plant spores and pollen indicates a favorable area for oil exploration where the reservoir is sandstone; an abundance of hystrichospherids might indicate a favorable area for oil exploration where the reservoir is a reefal limestone.

Microfossils can only show where the favorable areas are located. Geological and geophysical work in these favorable areas are necessary to locate traps for the accumulation of oil.

For articles on where and how tomorrow's oil will be found, see Current Outlook Section. Also the annual API-AGA report on U. S. reserves and a story on the exploration societies' meeting in New York City.

In conclusion it can be stated that microfossils are useful in oil exploration work for several reasons, some of which are listed below.

- Pollen, spores, and hystrichospherids are found in practically all types of sediments and have age ranges throughout the geologic column.
- Because of their small size they escape being crushed by the drilling bit and only a small amount of sample (five grams) is required for examination.
- The same prepared residue carries the four groups of microfossils referred to in this article and therefore no particular method for extracting any one group is required.
- They are useful for quick age determinations.
- Microfossils make good environment markers and can thus be used to separate the favorable areas from the unfavorable areas for oil exploration.

—The End

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About the Author

DR. WILLIAM S. HOFFMEISTER, senior research geologist at The Carter Oil Company Research Laboratory, was born in Baltimore, Md. He attended Johns Hopkins University where he received an A.B. degree in 1923 and a Ph.D. degree in 1926. After graduation he spent fifteen years doing paleontological work for Creole Petroleum Corporation, and was transferred to The Carter Oil Company in Shreveport in 1941. In 1946 he joined the newly organized Geological Research Section at The Carter Oil Company Research Laboratory in Tulsa. He is a Fellow of the Geological Society of America, a member of AAPG, SEPM, and the Tulsa Geological Society.

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Exploratory Drilling—In February and First Two Months 1955-1954

State or District	MONTH OF FEBRUARY, 1955													FIRST TWO MONTHS, 1955													
	Productive Tests									Total Productive	Unproductive Tests			Total Exploratory Tests	Productive Tests								Total Productive	Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions								New Fields			New Pays			Extensions									
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	2 Mo. 1955	2 Mo. 1954	Wildcats	New Pays	Outposts	2 Mo. 1955	2 Mo. 1954	2 Mo. 1955	2 Mo. 1954
Alabama											8			8												14			14	7	14	7
Arizona																										4			4	1	4	1
Arkansas	1						2			3	12		1	16	2			2			3			7	1	21		2	23	14	30	15
California	2			1		1	2			6	16		2	24	2			3	1	2	3			11	10	39		3	42	66	53	76
Colorado	2		1	1					1	5	55		7	67	8		4	2		1	3		1	19	11	113		10	123	53	142	64
Florida											3			3											1	8			8	7	8	8
Georgia																													1		1
Idaho											1			1												1			1		1	
Illinois				2						2	21			23	2			4			6			12	24	74			74	91	86	115
Indiana	2									2	13			15	5									5	3	24			24	42	29	45
Kansas	11		3	4						18	62			80	23		8	4						35	25	124			124	111	159	136
Kentucky	1									1	5			6	3									3	7	12			12	11	15	18
Louisiana		2		4	2	1	2			11	31		2	44	2	2		13	7	2	8	3	2	39	35	65		7	72	63	111	98
North Louisiana											14			14				1		1	2	2		6	5	29		2	31	20	37	25
South Louisiana		2		4	2	1	2			11	17		2	30	2	2		12	7	1	6	1	2	33	30	36		5	41	43	74	73
Michigan											18			18	1									1	1	42			42	49	43	50
Mississippi	2									2	17		2	21	2			2						4	1	31		3	34	18	38	19
Missouri																										5			5	4	5	4
Montana											14			14	1						1			2	2	22			22	22	24	24
Nebraska	4						1			5	22		3	30	8						1			9	7	43		4	47	17	56	24
Nevada											2			2												3			3		3	
New Mexico	5		1	1			3		2	12	8			20	7	1	2	3			5		5	23	12	17		1	18	40	41	52
North Dakota											1			1							2			2	2	5			5	18	7	20
Ohio																		1					1	2	1	4			4	1	6	2
Oklahoma	6		2	1		1	3			13	25	1		39	13	2	2	3		2	6	1	1	30	49	72	1	2	75	108	105	157
South Dakota																										2			2	4	2	4
Texas	38	5	8	27	4	4	5	1	1	93	366	1	5	465	88	8	17	44	9	4	22	4	2	198	205	705	2	7	714	661	912	866
Dist. 1 S. Central		2		1						3	39			42	3	2		2						7	9	64			64	41	71	50
Dist. 2 Middle Gulf	3	2	1	1	1	1				9	14			23	3	3	4	3	1	1				15	8	37			37	35	52	43
Dist. 3 Upper Gulf	1	1	1	6		1		1		11	31		1	43	3	2	2	9	3	1	3	3	1	27	27	67		3	70	68	97	95
Dist. 4 L. Gulf-S.W.	1			6	2	2				11	38		1	50	4	1	1	10	4	2				22	26	72		1	73	53	95	79
Dist. 5 E. Central	1									1	11			12	2			1						3	2	20			20	17	23	19
Dist. 6 Northeast											16		1	17							1			1	2	27		1	28	22	29	24
Dist. 7-B N. Cent.	14		3	3			2			22	67			89	29		5	4			6			44	43	149			149	164	193	207
Dist. 7-C W. Cent.	1		2	2	1				1	7	19	1		27	6		3	3	1		1		1	15	14	45	2		47	69	62	83
Dist. 8 West	5		1	4			1			11	36		1	48	9		1	6			8			24	34	73		1	74	72	98	106
Dist. 9 North	12			4			2			18	92		1	111	29		1	6			3			39	36	147		1	148	111	187	147
Dist. 10 Panhandle											3			3								1		1	4	4			4	9	5	13
Utah	1		1			1				3	7			10	2		1			1				4	2	13			13	3	17	5
West Virginia											3			3			2							2		3			3		5	
Wyoming	5			1			2			8	9		3	20	5		1	1			2		3	12	25	30		3	33	39	45	64
Total U. S.	80	7	16	42	6	8	20	1	4	184	719	2	25	930	174	13	38	81	17	12	62	8	15	420	424	1496	3	42	1541	1451	1961	1875

Exploratory Tests Eclipse 1954 Total by 86 Wells

By CECIL W. SMITH, WORLD OIL Staff

EXPLORATORY DRILLING in February declined from the previous month's rate, as is customary each year, but the number of tests completed was substantially more than that recorded in February, 1954. This increase boosted the year's total, which had trailed last year's, to a lead of 86 wells, or 4.6 percent.

February's 930 exploratory tests represented a drop of 101 wells, or 9.8 percent, from January's 1031, while a year earlier, February's dropped 213 wells, a 20 percent decline. As a result, the year's first two-months' tests numbered 1961 to last year's 1875.

Although activity this year was some greater than in the comparable 1954 period, a greater portion of the wells were dry holes. Failures this year totaled 1541 in two months, compared with 1451 a year earlier. This year's 424 producers amounted to 21.4 percent of total tests drilled, while in 1954, exploration had enjoyed a 22.6 percent batting average.

Among the principal drilling states, those that increased operations numbered about the same as those that experienced declines. However, out of the top five areas, only one recorded a deficit compared with 1954. Topping the list was Texas, where a gain from 866 to 912 represented a hike of 5.3 percent, a little more than the national average.

Kansas attained the Number 2 spot with 159 completed tests, an increase of 16.9 percent. Colorado climbed into Number 3 position with a gain of 121.9 percent. A 13.3 percent rise boosted Louisiana to Number 4 spot.

Summary of Results of Exploratory Drilling

ITEM	Feb., 1955	Jan., 1955	TWO MONTHS January-February 1955	1954	Percent Diff.
Oil Discoveries	122	133	255	267	— 4.5
New Fields	80	94	174	191	— 8.9
New Pays	42	39	81	76	+ 6.6
Distillate Discoveries	13	17	30	43	— 30.2
New Fields	7	6	13	22	— 40.9
New Pays	6	11	17	21	— 19.1
Gas Discoveries	24	26	50	48	+ 4.2
New Fields	16	22	38	43	— 11.6
New Pays	8	4	12	5	+140.0
Total Discoveries	159	176	335	358	— 6.4
Extension to Fields	25	60	85	66	+ 28.8
Oil Fields	20	42	62	50	+ 24.0
Distillate Fields	1	7	8	6	+ 33.3
Gas Fields	4	11	15	10	+ 50.0
Total Prod. Tests	184	236	420	424	— 1.0
Dry Holes	746	795	1541	1451	+ 6.2
Wildcats	719	777	1496	1443	+ 3.7
New Pays	2	1	3	.....	.....
Outposts	25	17	42	8	+425.0
Total Expl'tory Tests	930	1031	1961	1875	+ 4.6
Percent Productive	19.8	22.9	21.4	22.6	.....
Percent Dry	80.2	77.1	78.6	77.4	.....

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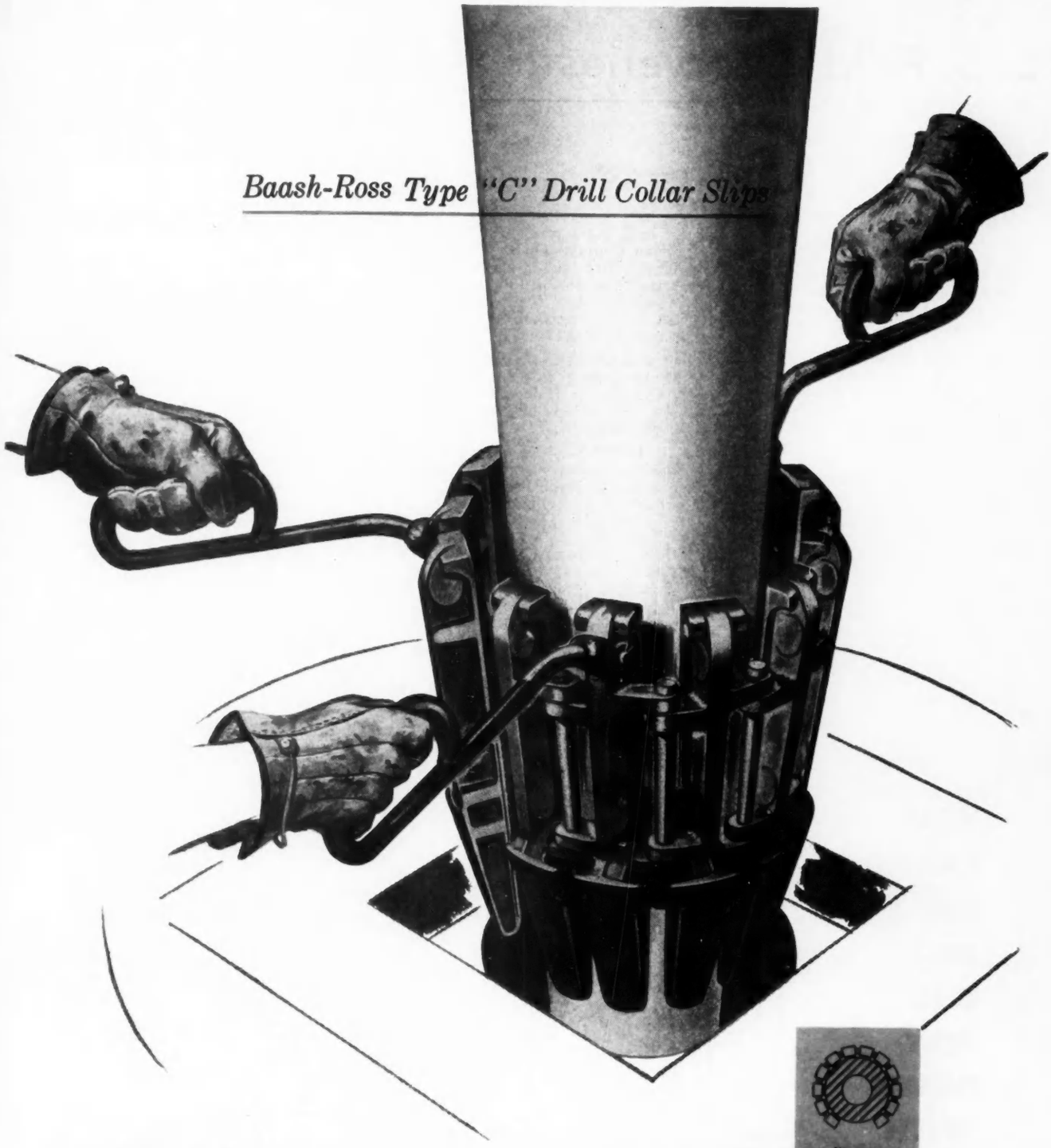

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U. S. Field Discoveries in February

(Not Including New Pays and Extensions)

ARKANSAS—NEW OIL FIELD

Union County, East Aurelle field. Olin Oil & Gas Corp.'s Theo Hankton 1, C NW NE SW 19-19s-12w, pumped 9 barrels oil and 81 barrels water from Nacatoch sand, Upper Cretaceous 2339-50 feet, completed 1-24-55, TD 2350.

CALIFORNIA—NEW OIL FIELDS

Fresno County, Polvadero Gap field. Los Nietos Co., Operator's Bourdieu 55-1, in 1-21s-16e, flowed 1594 barrels from Gatchell sand, Eocene 10,612-677 feet, 26/64-inch, 30.2-gravity, completed 2-7-55, TD 10,737.

Ventura County, Montalva, West field. Sunray Oil Corp.'s Sunray-Ohio-Baillard-McGrath 1, in 31-2n-22w, pumped 49 barrels oil and 8 barrels water from Sespe sand, Oligocene 11,765-785 feet, 19.2-gravity, completed 1-14-55, TD 13,462.

COLORADO—NEW OIL FIELDS

Adams County. Lubar Oil Co., Ryan Oil Co. & Davis Oil Co.'s UPRR-5 1, SW SW SE 5-3s-57w, pumped 70 barrels oil and 150 barrels water from Dakota "J" sand, Upper Cretaceous 5656-62 feet, completed 3-5-55, TD 5730.

Logan County. Great Basins Petroleum Co.'s McEdnaffer 41-19, C NE NE 19-10n-54w, flowed 135 barrels oil and 12 barrels water from Dakota "J" sand, Upper Cretaceous 5225-27 feet, ¼-inch, completed 2-17-55, TD 5357.

COLORADO—NEW GAS FIELD

Moffat County, Lay Creek area. Moore & Gilmore, & Halbert & Jennings' Kern 1, SE NE 13-8n-93w, ungaged, completed 2-5-55, TD 7385.

INDIANA—NEW OIL FIELDS

Daviess County. Sterling Drilling Co.'s Ralph & Jessie Richardson 1, NW NW NW 26-5n-5w, pumped 17 barrels from Salem lime, Mississippian 802-805 feet, TD 820.

Dubois County. Carl E. Michel's Elmer Roesner 1, NE SE NE 35-3s-6w, pumped 50 barrels from Aux Vases sand, Mississippian 1122-30 feet, TD 1149.

KANSAS—NEW OIL FIELDS

Barber County, Unnamed field. Aurora Gasoline Co. & Jones, Shelburne & Farmer's McKeever 1, SE SE SE 13-32s-10w, pumped 40 barrels from Mississippi lime, Mississippian 4355-65 feet, TD 4899.

Unnamed field. Purcell-Mull's Kisling 1, SW SW NE 25-31s-12w, flowed 83 barrels from Mississippi sand, Mississippian 4284-96 feet, TD 4308.

Decatur County. Walt Sauvage's Jones 1, NE NE SE 29-2s-28w, pumped 15 barrels from Lansing lime, Pennsylvanian 3567-71 feet, TD 3687.

Ellis County, Toulon, Southwest field. Leben Oil Co.'s Dinkel 1, SE SE NW 16-14s-17w, pumped 25 barrels oil and 25 barrels water from Arbuckle lime, Ordovician 3508-14 feet, TD 3514.

Unnamed field. G-M-R Oil Co.'s Walter 1-A, NW SW SE 4-13s-17w, pumped 90 barrels from Lansing lime, Pennsylvanian 3409-13 feet, TD 3607.

Graham County. Heathman-Seeligson Drilling Co.'s Irwin 1, SW SW NE 12-10s-23w, pumped 357 barrels from Pennsylvanian Conglomerate 4088-99 feet, TD 4200.

Kingman County, Unnamed field. Carter Oil Co.'s Spade 1, NW NW NE 27-29s-10w, pumped 6 barrels oil and 20 barrels

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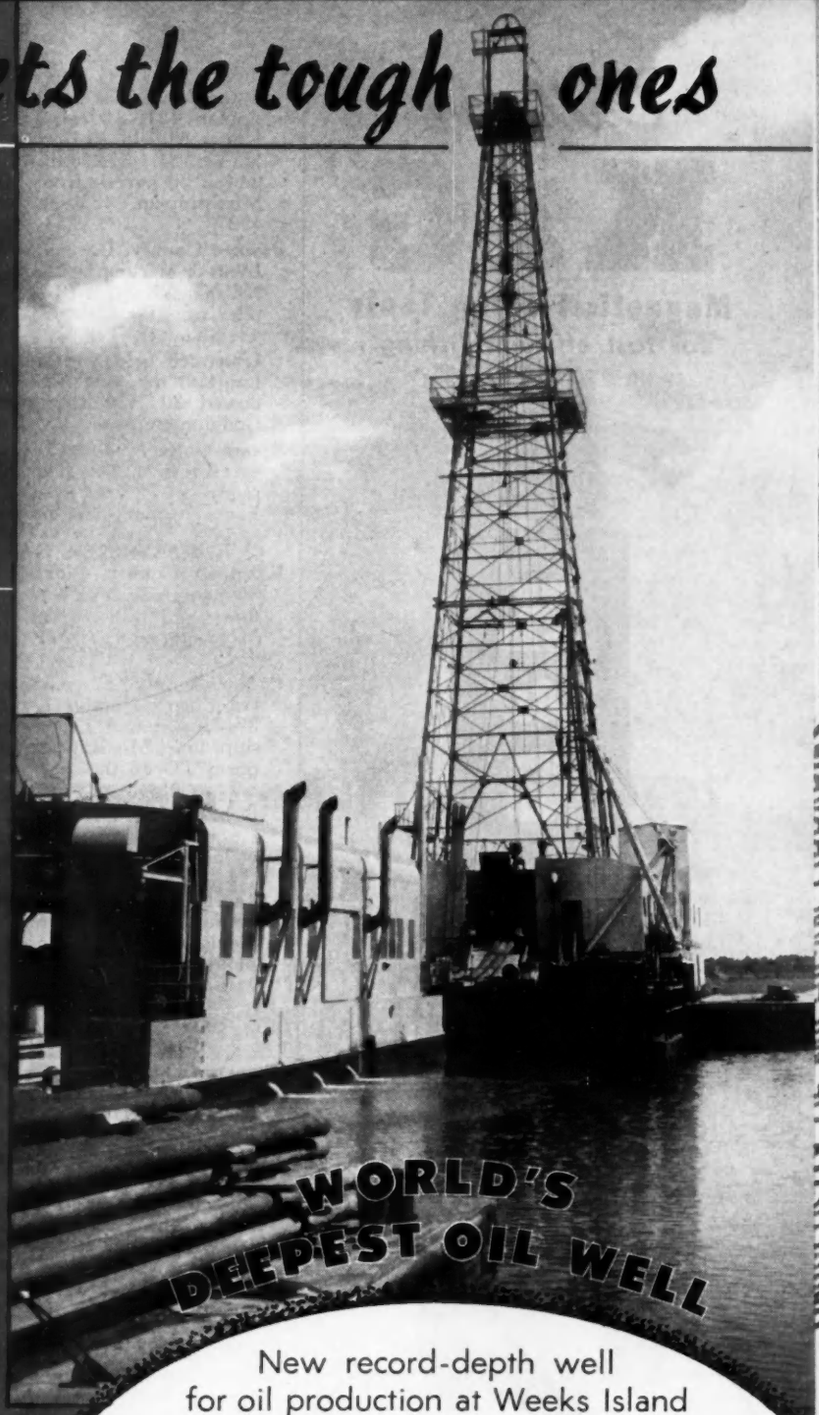

New record-depth well for oil production at Weeks Island Field in Louisiana, flowed 410 barrels of 29.5 gravity oil daily through a small choke from 16,834-44 feet. Deeper wells have been completed as gas or condensate producers but crude oil has never before been found at such depth. The previous record holder, in Kern County, California, was producing oil at 15,530 feet.

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LOUISIANA: Shreveport, 3-1648 — Lake Charles, HE-9-4724 — Lafayette, 4-2396 — Houma, 2-2771. KANSAS: Great Bend, 4306 — Liberal, 4822
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water from Mississippi lime, Mississippian, 4312-21 feet, TD 4800.

Unnamed field. El Dorado Refining Co.'s McCalla 1, NE SE NW, 11-30s-9w, flowed 20 barrels from Mississippi lime, Mississippian, 4230-38 feet, open, TD 4297.

Pawnee County, Garfield, West field. J. J. Lynn & Sterling Drilling Co.'s Strobel 1, NE NE NE 3-23s-18w, pumped 39 barrels from Pennsylvanian Conglomerate, 4310-23 feet, TD 4743.

Unnamed field. Hilton Drilling Co.'s Lanterman 1, NW NW NW 1-23s-17-w, flowed 30 barrels from Pennsylvanian Conglomerate, 4150-56 feet, TD 4257.

Rooks County. Petroleum, Inc.'s Carmichael 1, NE NW SW 33-8s-18w, pumped 474 barrels from Lansing lime, Pennsylvanian, 3210-63 feet, TD 3440.

KANSAS—NEW GAS FIELDS

Kingman County. Pickrell Drilling Co.'s Swingle A-1, NW NW NW 36-30s-9w, flowed 1.5 million from Mississippi sand, Mississippian, 4314-29 feet, open, TD 4425.

Kiowa County. Falcon-Seaboard & Gulf Oil Corp.'s Nichols 1, NE NE NW 20-29s-18w, flowed 7.2 million from Mississippi lime, Mississippian, 4997-5168 feet, open, TD 5630.

Pawnee County. Loffland Brothers Corp.'s Grizzell 1, SW SW SE 23-23s-15w, flowed 1.6 million from Simpson sand, Ordovician, 4084-4110 feet, open, TD 4150.

KENTUCKY—NEW OIL FIELD

Christian County. Walter Sargent & Pat Vogler's L. L. Grace 1, in 22-H-26, pumped 225 barrels from Jackson sand, Mississippian, 553-578 feet, TD 578.

SOUTH LOUISIANA—NEW DISTILLATE FIELDS

Cameron Parish. Magnolia Petroleum Co.'s Ellen Cox 1-X, in 32-12s-7w, flowed 177 barrels distillate and 1.9 million from Lower Miocene sand, 13,612-16 feet, 8/64-inch, 47.6-gravity, completed 2-11-55, TD 13,830.

Plaquemines Parish, West Delta—Block 58 field. Continental Oil Co.'s State Lease 983-1-A, Gulf of Mexico, flowed 245 barrels distillate and 1.9 million from 11,668-678 feet, 11/64-inch, 53-gravity, completed 1-31-55, TD 14,580.

MISSISSIPPI—NEW OIL FIELDS

Adams County, Unnamed field. E. C. Wentworth's Natchez Country Club A-1, in 12-7n-3w, flowed 275 barrels from Wilcox sand, Eocene, 4370-75 feet, 11/64-inch, 40-gravity, completed 2-3-55, TD 4406.

Unnamed field. John S. Callon & T. J. Glennon's Board of Supervisors A-1, in 47-6n-1w, pumped 101 barrels oil and 25 barrels water from McKittrick (Wilcox) sand, Eocene, 6229-34 feet, 39-gravity, completed 2-18-55, TD 6660.

NEBRASKA—NEW OIL FIELDS

Banner County. Empire Drilling Co.'s Olsen 1, NE NE NE 2-18n-56w, pumped 66 barrels from Dakota "D" sand, Upper Cretaceous, 5811-18 feet, completed 3-8-55, TD 5991.

Cheyenne County. Max Pray & John L. Nelson's Henry 1, NW NW SW 31-16n-51w, pumped 90 barrels from Dakota "J" sand, Upper Cretaceous, 5217-22 feet, completed 1-16-55, TD 5305.

Kimball County, Unnamed field. Ryan Oil Co.'s Schneider 1, NW NW NW 30-16n-53w, pumped 200 barrels from Dakota "J" sand, Upper Cretaceous, 5782-88

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feet, 38-gravity, completed 2-15-55, TD 5826.

Unnamed field. F. P. Zoch & Love-Miller Drilling Co.'s Nora E. Pound 1, C NW NE 14-16n-54w, pumped 295 barrels from Dakota "J" sand, Upper Cretaceous, 5786-90 feet, completed 2-24-55, TD 5825.

NEW MEXICO—NEW OIL FIELDS

Chaves County, Unnamed field. Morris R. Antwell's Williams 1, in 33-14s-31e, flowed 528 barrels from Queen sand, Permian, 3087-3100 feet, ½-inch, 36-gravity, completed 1-25-55, TD 3100.

Unnamed field. Neville G. Penrose's A. L. Estate 1, in 20-15s-31e, pumped 61 barrels from Queen sand, Permian, 3139-45 feet, 38-gravity, completed 2-14-55, TD 3145.

Eddy County, Unnamed field. O. H. Randel & O. F. Featherstone's McLean 1, in 27-18s-30e, flowed 72 barrels from Queen sand, Permian, 2815-3046 feet, 36-gravity, completed 2-5-55, TD 3393.

Unnamed field. G. K. Woods' Rayroux 1, in 24-21s-26e, Old Well Worked Over, pumped 3 barrels oil and 60 barrels water from Delaware lime, Permian, 2643-3206 feet, 27-gravity, completed 2-15-55, TD 3206.

Lea County. Superior Oil Co.'s State "335" 1, in 19-13s-32e, flowed 158 barrels oil and 2 barrels water from Pennsylvanian sand, 11,097-114 feet, 25/64-inch, 41.5-gravity, completed 1-27-55, TD 12,519.

NEW MEXICO—NEW GAS FIELD

Rio Arriba County. Jay J. Harris' Jicarilla 1, NW SE NE 28-24n-5w, flowed 5.9 million from Pictured Cliffs sand, Upper Cretaceous, 2218-70 feet, completed 2-22-55, TD 2270.

OKLAHOMA—NEW OIL FIELDS

Coal County. W. H. Sherin & Son's Skirvin 1, NW SE SW 20-2n-9e, Old Well Worked Over, flowed 191 barrels from Hunton lime, Devonian, 5785-96 feet, 14/64-inch, 41-gravity, TD 7571.

Kay County. O. F. Warren Corp.'s Louis Cisneros 1, NE SW SE 23-26n-2w, flowed 12 barrels from Mississippi Chat, 4110-23 feet, 3/16-inch, 40-gravity, TD 4335.

Noble County, Unnamed field. LaGorce Oil Co.'s Mary Sanders 1, NE SE NW 3-21n-1w, pumped 10 barrels oil and 3 barrels water from Sams sand, Permian, 1630-39 feet, 39-gravity, TD 3974.

Unnamed field. Pace Petroleum Co., Inc.'s Odenwald 1, NW NW NE 18-24n-1w, flowed 6 barrels from Mississippi Chat, 4364-85 feet, 10/64-inch, 48-gravity, TD 4385.

Pawnee County. Glenn Gillespie & Sons' Hugh Ross 1, SE SE NW 29-22n-7e, Old Well Drilled Deeper, pumped 25 barrels oil and 80 barrels water from Misener sand, Mississippian, 2906-11 feet, TD 3146.

Tillman County. Anderson & Helton Oil Co.'s Frank Moss 1, SE SE SE 15-3s-17w, pumped 3 barrels oil and 4 barrels water from Lower Cisco sand, Pennsylvanian, 3045-49 feet, 41-gravity, TD 3275.

OKLAHOMA—NEW GAS FIELDS

Grady County. Superior Oil Co.'s Gordon 1, NW NW SE 16-8n-20e, flowed 4.7 million from Atoka sand, Pennsylvanian 5567-82 feet, ¾-inch, and 4.1 million from Cromwell sand, Pennsylvanian, 5955-69 feet, ¾-inch, TD 6074.

Pawnee County. Lee Oil Co.'s Julia Troth 1, NE NW NW 5-22n-6e, flowed 3.5 million from Lower Skin sand, Pennsylvanian 2706-12 feet, 24/64-inch, TD 3161.

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FORMATION BIT DIA. (IN.)	TOTAL FOOTAGE	PENETRATION RATE	TOTAL COST	BIT COST PER FOOT	BIT LOAD POUNDS PER INCH	DRILLING RPM	CONDITIONS FL. VOL
WILDCAT FIELD, ROOSEVELT, MONTANA							
Shale, dolomite, lime, anhydrite 6"x2⅝"	1365 ft.	1-4 ft. hr.	$1575.00	**$1.15**	8,000-12,000	60-65	200-300 gpm
WILDCAT FIELD, CHEYENNE COUNTY, NEBR.							
Dakota and shale 6⅛"x3½"	700 ft.	4 ft. hr.	$1072.10	**$1.53**	8,000-14,000	60-70	200 gpm
BISTENAU FIELD, WEBSTER COUNTY, LA.							
Cotton Valley Lime 4¾" HSF	456 ft.	2.8 ft. hr.	$1563.70	**$3.43**	6,000	90-100	130 gpm
KILDARE FIELD, CASS COUNTY, TEXAS							
Shale, lime, sand 4¾" D.C. Drilling	565 ft.	3-4 ft. hr.	$1107.30	**$1.96**	6,000-10,000	80-120	120-130 gpm

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TEXAS DISTRICT 1—NEW DISTILLATE FIELDS

McMullen County, "Syndicate" field. H. R. Smith's South Texas Syndicate 1, GWT & P RR Survey, flowed 4 barrels distillate and 4.2 million from Edwards lime, Lower Cretaceous, 10,658-82 feet, open, 47.6-gravity, completed 1-20-55, TD 10,910.

Unnamed field. Standard Oil Co. of Texas' J. B. Dilworth 1-1, Hugh Frazier Survey, flowed 16 barrels distillate and 11.3 million from Georgetown-Edwards lime, Lower Cretaceous, 11,170-270 feet, open, completed 1-31-55, TD 11,395.

TEXAS DISTRICT 2—NEW OIL FIELDS

Bee County, Mudhill field. Hillsman-Greenburg Oil Co.'s Roberts Estate 1, Oscar Farris Survey, pumped 19 barrels from Hockley sand, Eocene, 3161-69 feet, 41-gravity, completed 1-7-55, TD 3175.

Live Oak County, "Mikeska" field. Appell Drilling Co.'s Northern Royalty Co. 1, Thomas Catillo Survey, pumped 45 barrels from Pettus sand, Eocene, 4346-51 feet, 43-gravity, completed 12-10-54, TD 4351.

Victoria County, Koontz, North field. A. J. Bankhead's H. C. Koontz Estate 1, Brown & Dodd Subdivision of McCutcheon Ranch, Block 23, flowed 70 barrels oil and 170 barrels water from Frio sand, Oligocene, 6078-80 feet, 10/64-inch, 31-gravity, completed 1-22-55, TD 6762.

TEXAS DISTRICT 2—NEW DISTILLATE FIELDS

Bee County. Holmes Drilling Co. & Robert Mosbacher's Annie Pearl Collier 2, Patrick Carroll Survey, flowed 420 barrels distillate and estimated 7.0 million from Wilcox sand, Eocene, 9221-25 and 9233-37 feet, open, completed 2-20-55, TD 11,040.

Goliad County, "Yanta" field. Kirkwood & Co. & W. Carlton Weaver's John Yanta 1, Maria de Jeus Y Barbo Survey, ungaged from Wilcox sand, Eocene, 7538-42 feet, completed 2-5-55, TD 8018.

TEXAS DISTRICT 2—NEW GAS FIELD

Victoria County, "East Collettoville" field. Currie B. Davis' A. R. Krause 1, Cecelia de la Garza Survey, flowed 12.0 million from Frio sand, Oligocene, 3579-82 feet, open, completed 2-3-55, TD 4450.

TEXAS DISTRICT 3—NEW OIL FIELD

Harris County. Sinclair Oil & Gas Co.'s Mary A. Fraser 1, Charles Clarkson Survey, pumped 87 barrels from Cockfield-Yegua (DY) sand, Eocene, 6560-64 and 6571-73 feet, 41.1-gravity, completed 1-15-55, TD 7945.

TEXAS DISTRICT 3—NEW DISTILLATE FIELD

Galveston County. John W. Mecom's Ervine & Bishop 4, Alex Farmer League, flowed 2000 barrels distillate and 10.5 million from Frio sand, Oligocene, 13,434-450 feet, open, 53.6-gravity, completed 1-18-55, TD 15,028.

TEXAS DISTRICT 3—NEW GAS FIELD

Matagorda County. Kirkwood & Morgan, Inc.'s Lacy Armour et al 1, Benjamin Rawls & O. H. Stout League, ungaged from 2848-54 and 2898-2902 feet, completed 12-20-54, TD 8800.

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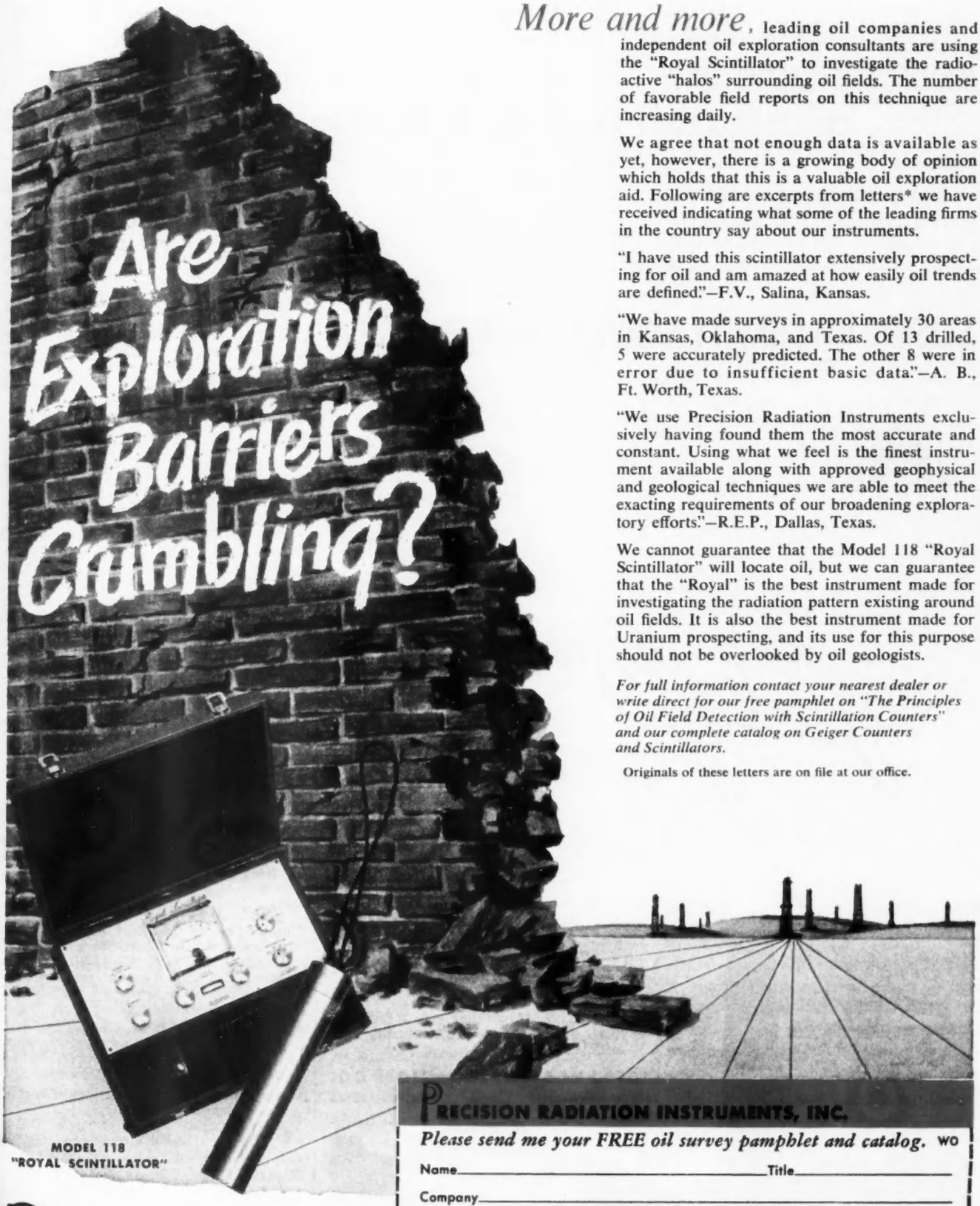

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TEXAS DISTRICT 4—NEW OIL FIELD

Nueces County. Gulf Oil Corp.'s Texas State Lease 41338 - 1, Gulf of Mexico, Block 889, flowed 140 barrels from Frio sand, Oligocene, 11,542-486 feet, 10/64-inch, 47-gravity, completed 2-1-55, TD 11,704.

TEXAS DISTRICT 5—NEW OIL FIELD

Limestone County. Humble Oil and Refining Co.'s Joe Ross Heirs 1, Pedro Varela Survey, flowed 121 barrels from Smackover lime, Jurassic, 8565-76 feet, ¼-inch, 50.1-gravity, completed 2-10-55, TD 8619.

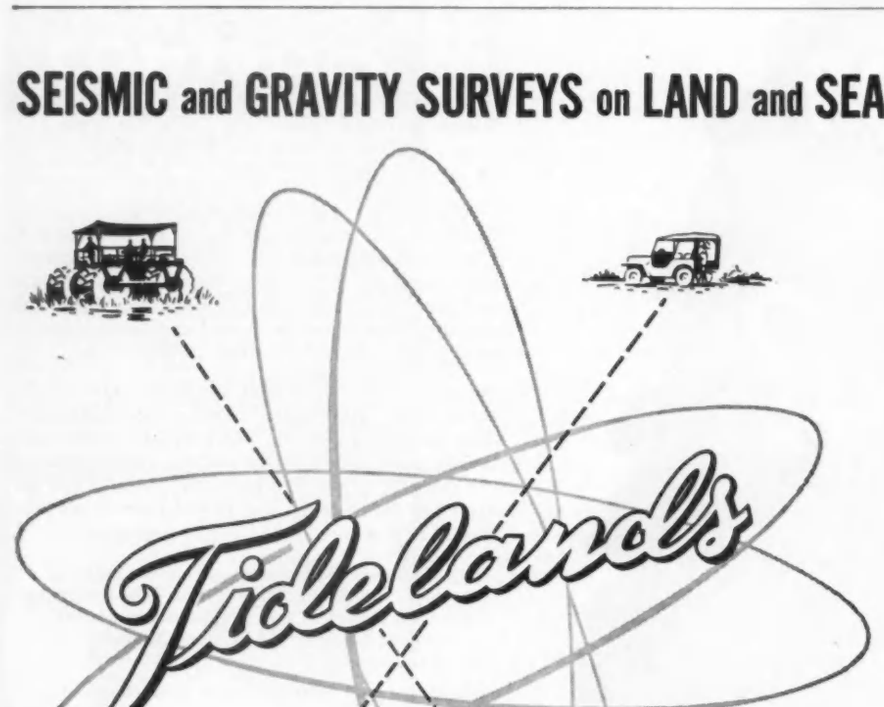
TEXAS DISTRICT 7-C—NEW OIL FIELD

Tom Green County. L. L. Lookabaugh, Jr., et al's John Y. Rust Estate 1, San Saba CSL Survey, flowed 161 barrels from Ellenburger lime, Ordovician, 6603-17 feet, 10/64-inch, 48-gravity, completed 2-10-55, TD 6617.

TEXAS DISTRICT 7-C—NEW GAS FIELDS

Sutton County, Unnamed field. Ada Oil Co.'s Hubert Fields 1-51, Section 51, Block B, HE&WT Survey, flowed 0.1 million from Canyon sand, Pennsylvanian 5335-5445 feet, open, completed 11-24-54, TD 7165.

Unnamed field. El Paso Natural Gas Co.'s Fields Estate 1, Section 22, Block 1, HE & WT Survey, flowed 1.6 million from Canyon sand, Pennsylvanian, 5302-20 feet, open, completed 2-4-55, TD 5700.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TEXAS DISTRICT 8—NEW OIL FIELDS

Andrews County. White Eagle Oil Co. & Lumac Drilling Co.'s Savage 1, Section 17, Block A-36, PSL Survey, pumped 104 barrels oil and 12 barrels water from Grayburg lime, Permian, 4316-4476 feet, 31.6-gravity, completed 12-24-54, TD 4522.

Crane County. Bankline Oil Co. et al & Lario Oil & Gas Co.'s R. N. Beakley et al 1, Section 24, Block 2, H&TC Survey, pumped 61 barrels oil and 5 barrels water from Tubb lime, Permian, 3941-4015 feet, 37-gravity, completed 1-30-55, TD 6665.

Midland County. Ernest Fletcher's V. B. Clark 1, Section 50, Block 11, H&GN Survey, pumped 30 barrels from Glorieta lime, Permian, 2997-3067 feet, 36.4-gravity, completed 2-1-55, TD 4743.

Scurry County. Forest Oil Corp.'s H. H. Eiland 1, Section 167, Block 97, H&TC Survey, flowed 208 barrels oil and 20 barrels water from Reef lime, Pennsylvanian, 6848-54, 7202-10 and 7234-42 feet, 19/64-inch, 42.6-gravity, completed 1-21-55, TD 7400.

Sterling County. W. M. & A. P. Fuller's W. R. Davis 1, Section 73, Block 2, H&TC Survey, flowed 353 barrels from Strawn sand, Pennsylvanian, 6874-6950 feet, ¼-inch, 41-gravity, completed 2-15-55, TD 7000.

TEXAS DISTRICT 8—NEW GAS FIELD

Pecos County. G. D. Putnam & Co. et al's McDonald & State 1, Section 6, Block F, TCRR Survey, Old Well Drilled Deeper, flowed 7.9 million from Lower Clearfork lime, Permian 2910-4995 feet, open, completed 2-2-55, TD 4995.

UTAH—NEW OIL FIELD

Grand County. Carter Oil Co.'s Larsen-State 1, NE NW 2-20s-24e, flowed 126 barrels from Morrison sand, Jurassic, 1429-45 feet, 38-gravity, completed 2-25-55, TD 1455.

UTAH—NEW GAS FIELD

Duchesne County. Superior Oil Co. & Carter Oil Co.'s Bluebell Unit 2, SW NW 3-1s-2w, flowed 5.4 million from Green River sand, Eocene, 7895-7909 feet, completed 2-6-55, TD 9728.

WYOMING—NEW OIL FIELDS

Carbon County. McElroy Ranch Co.-Natural Gas & Oil Corp.-Bruce Anderson's Horne 1, SW NW NE 11-20n-79w, ungaged, from Sundance sand, Jurassic 6100-72 feet, completed 2-25-55, TD 6507.

Crook County. M.K.M. Oil Co.'s Government 2, SE SE SW 33-49n-66w, pumped 12 barrels from Turner sand, 598-618 feet, completed 1-31-55, TD 674.

Goshen County. F. R. Anderson's Torrington Airport 24-D-33, SE SE SW 33-24n-61w, pumped 72 barrels from Dakota "J" sand, Upper Cretaceous, 6917-25 feet, completed 2-11-55, TD 7101.

Niobrara County. Sure Oil Co.'s Ballard 1, C NE NE 15-40n-66w, flowed 132 barrels from Newcastle lime, Upper Cretaceous, 7707-15 feet, ¼-inch, completed 2-21-55, TD 7777.

Washakie County. Sohio Petroleum Co.'s Water Creek Unit 1, SE SE SE 36-44n-91w, pumped 325 barrels from Phosphoria lime, Permian, 6005-21 feet, 21.4-gravity, completed 2-22-55, TD 6418.

Keen competition and a united effort between contractors and operators have improved . . .

Drilling Practices in the Permian Basin

By R. J. BROMELL, Great Western Drilling Company, Midland, Texas

KEEN COMPETITION has brought about a united effort on the part of contractors and oil operators to solve mutual problems in the Permian Basin. This free exchange of information has led to improved practices which would have been impossible without the cooperation from drilling contractors, equipment manufacturers, service companies, suppliers, and operators. In some instances the effect of jointly studying problems has been reflected in relaxation of certain contract clauses; while the operators benefit from improved practices through more hole for their money. But aside from monetary gain, better relations have been established.

They have studied:

- Increased Weight
- Large Drill Collars
- Chert Bits
- Jet Bits
- Drill Pipe
- Pumps
- Air and Gas Drilling
- Feed Controls
- Hydraulic Equipment

Increased Weight. Bit weights have increased greatly during the past two years. Normal practice of carrying 30,000 to 40,000 pounds on 12¼-inch bits has increased to 70,000 to 110,000 pounds while 8¾-inch bits are carrying 50,000 to 80,000 pounds instead of the 30,000 to 45,000 pounds of two years ago. Some contractors are carrying 70,000 pounds on 7⅞-inch bits and 50,000 pounds on 6¾-inch bits This is not considered a general practice as yet. Average weights in 7⅞-inch hole are from 35,000 to 50,000 pounds and in 6¾-inch hole, 30,000 to 35,000 pounds.

Increased weight on the 12¼-inch bits is due largely to the jet bit. Without the aid of jet bits a great deal of the benefit derived by increased weight in the softer formations would be impossible.

Many problems aggravated by increased weight have become topics for study by various groups. Among those considered most important are: 1. Crooked hole; 2. drill-collar cost and maintenance, and 3. bit life as related to weight and rotary revolutions per minute. All of the foregoing problems are now much less formidable than they were two years ago.

Drill Collars. The changes in drill collar practice in the last two years are not really changes, but rather are a widespread acceptance of practices considered experimental two years ago.

In drilling 8¾-inch hole, 6¼-inch outside diameter collars were the usually accepted drill-collar size two years ago. Frequently collars worn to as small as 5¾-inch OD were used. Now 7-inch OD or 6¾-inch OD collars are the usual size of collars in 8¾-inch hole. Overshot fishing tools and wash pipe are available for conventional washover and fishing procedures for retrieving 7-inch collars in 8¾-inch hole.

Two years ago, few companies were drilling with 8-inch collars in 8¾-inch hole as a means of combatting crooked hole. Because these collars were not retrievable by conventional washover procedure, they were termed "oversize collars." The use of oversize collars, 7-inch in 7⅞-inch hole and 8-inch in 8¾-inch hole, has become quite common. Frequently only 1, 2, or 3 of these collars are used below a conventional string, but a number of companies have now run full strings on many wells.

Operational success has been considerable, not only in minimizing the severity of crooked-hole zones, but also in improved bit performance. One operator reports that the use of a full string of 7¾-inch collars in 8¾-inch hole consistently resulted in greater footage per bit in considerably less hours than on an offset location drilled at the same indicated weight with 6-inch collars in 8¾-inch hole. Others have reported a similar trend. Apparently the larger collars minimize the loss of weight caused by buckling of the collar string against the wall of the hole and maintain uniform loading of the bit. It has been demonstrated that using small collars above the bit results in bending of the bottom collar with a corresponding "walking" of the bit, alternately loading one cutter at a time. This walking of the bit produces accelerated bit wear and bearing damage, and loss of the efficiency of cutting action of the bit.

The expected loss of many strings of oversize collars and junked holes has not materialized. Eight-inch collars have been successfully retrieved from 8¾-inch hole by taper tap on many occasions. On at least three occasions, 7-inch collars have been washed over in 7⅞-inch hole by use of flush-joint 7⅝-inch wash pipe. A string of specially prepared wash pipe is available for washing over 8-inch collars in 8¾-inch hole. There is much less risk involved than was generally anticipated, and more general use of oversize collars is expected.

In the Permian Basin area today, many rig operators are using stress-relief features in all drill-collar joints; even more of them are using these features to combat excessive box failures as the OD of the collars wears down and the critical section of the box becomes thin. In areas where corrosion of the unengaged threads at the bottom of the box accelerate fatigue failure, stress relief features at this point which remove the stress

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concentration effect of these threads will minimize the corrosion fatigue problem.

One notable change in drill-collar practice in the Permian Basin is related to the increased bit weight now being used. This naturally implies a need for more drill collars or larger drill collars, or both. Two years ago, 18 to 20 6¼-inch OD drill collars were the average string run in 7⅞-inch hole. Now it is common to see 20 to 25 such collars in a string; and, on occasion, some strings of 30 or more 6¼-inch collars have been run in 7⅞-inch hole. The change to 7-inch OD collars in 8¾-inch hole has increased weight without increasing the number of collars in the string; but even here, more than 20 collars are sometimes used.

The loss of drill-collar weight and the weakening of the drill-collar joint box as the drill-collar diameter is reduced by wear have prompted the use of hard-facing materials to retard outside-diameter wear. Records indicate that, in the Permian Basin area, collars in continuous use may be expected to lose ¼-inch of diameter per year. Application of a 10-inch band of tungsten carbide hard-facing material about 20 inches above the pin shoulder has been surprisingly effective in retarding wear. Where drill collars have been lengthened by welding on stubs of larger diameter than the body of the collar, it is essential to protect the stubs with a wide band of hard-facing material, or they will soon be worn to the same diameter as the remainder of the string.

Chert bits. It was formerly believed that chert bits should be used in areas having a minimum of 20 to 30 percent chert, or at least should not be used if a conventional hard-formation bit would make 25. Chert bits are now replacing conventional bits in hard limestones and dolomites, especially where there are no inter-bedded shale streaks. Table 1 is presented to illustrate what improvement can be made through the use of chert bits.

The table is based on $40 per hour rig cost and includes rotating hours, trip time, and bit cost. Such marked improvements are not to be expected when drilling with mud. The exact difference between using chert bits in clear water and in mud has not been fixed, but results indicate that it is considerable. This problem is currently being given special study.

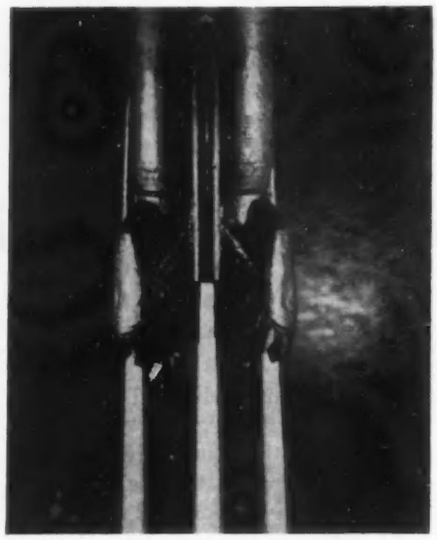

Fig. 1—Indexing sub designed to alternate flow through jet or conventional nozzle.

Jet Bits. Still a highly controversial subject is the merit of the jet bit. Among the users of jet bits, the proper methods of application are even more controversial.

Annulus velocities in the magnitude of 180 feet per minute are no longer believed by most operators as necessary to efficient jet drilling. Very successful operations while drilling in the red beds have been conducted with annulus velocities of 100-feet to 110-feet per minute. This was done with 530 gallons per minute to 560 gallons per minute, ½-inch nozzles, and 5½-inch OD drill pipe as compared to previous concepts of 880 gpm and ¾-inch nozzles. Horsepower required to get comparable results was 567 less at pipe joint.

Many operators use jet bits and enlarged nozzles to relieve pumps and engines with no regard for nozzle velocity, bit horsepower, impact force, or annulus velocity, and yet believe that jet bits pay off. Still other operators do not run jets at all because they believe that the return is not justified by the additional cost. Both cases are justified in their respective places; and until the entire drilling operation is meticulously anayzed and reliable answers given, some operators will continue to reap greater dividends with jet bits while others do the same with conventional.

Tests are being conducted to carefully evaluate jet bit performance.

It may be necessary to completely change jetting practices to coincide with drilling practices. An example would be that once a relationship is established between penetration rate and nozzle velocity at a given weight and rotary speed, such relationship might not hold true if either the weight or rotary speed change. The wide diversity of opinions on effectiveness of jet bits may well be the result of the effect of different drilling practices. It is believed that, once the basic questions are answered in the field tests, a method will be made available whereby the degree of improvement for specified conditions can be accurately determined.

What relationship actually exists between penetration rate, bit horsepower, weight on bit, annulus velocity, nozzle velocity, rotary speed, depth, and mud characteristics is indeed evasive, but must be determined. In the future we may find that crooked hole, forcing light weight in hard formations, the mud characteristics, and even the hydrostatic head on formations will be the basis for deciding if premium-priced jet bits should be used. This premium is a small amount; but when over 100 bits per well are used, the total figure is significant. What is more important about a study of this type is that once enough information is available to correctly evaluate the conditions favorable for jet bits, we will uncover many of our basic problems of penetration and through this understanding will greatly improve all our drilling practices.

An indexing sub (Figure 1) is being used to alternate fluid flow through conventional water courses and jet water courses. A comparison can be made in the penetration rate of alternate intervals. This tool can also be used to change size of jets while drilling; and, in this way, relations can be established among the many variables of jetting.

Drill Pipe. Jet bits have been responsible for many contractors changing to larger drill pipe. The once very popular 3½-inch OD pipe has

TABLE I

	All Regular Bits	Chert Bits and 1 Regular Bit
Interval, feet	6,758–8,013	6,811–8,053
Footage	1,255	1,242
Total Bits	22	5
Rotating Hours	170¾	182
Cost per Foot	$12.69	$10.92

given way to 4-inch OD and 4½-inch OD pipe. Intermediate holes of 11 inches or 12¼ inches are being drilled with more 5½-inch pipe now than several years ago.

At first glance one might be skeptical about some of the present-day trends toward larger pipe, since it seems we are reverting to old practices. More contractors are aware of the hydraulic advantages of the larger drill pipe and prefer using it, despite the extra weight in hoisting and higher initial cost of the pipe.

Although drill collars are the principal source of weight, some pipe weight is still used by the contractor especially when using 5½-inch OD pipe. This practice cannot be entirely criticized since the large demand for drill collars and need for weight can often justify using some pipe weight when using 5½-inch OD pipe.

Cost-conscious contractors and operators are looking over old discarded practices to re-evaluate them in the light of today's thinking. One of the significant "finds" from the past was actually stimulated by work done in California and careful examination of a war-imposed experiment designed to conserve time and material. Tests are currently in progress and others are proposed to exploit the practicability of threaded-and-coupled drill pipe, viz., drill pipe with couplings instead of tool joints. (Figure 2) On wells of medium depth, 5000 to 6000 feet, one string of 4½-inch OD Grade D drill pipe with couplings drilled 152,000 feet and a second is still in use after 95,000 feet of hole.

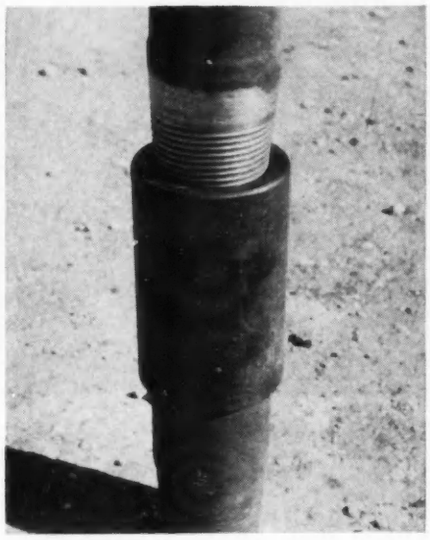

Fig. 2—Special joint design for threaded-and-coupled drill pipe.

Improved metallurgy may make it possible to extend this same type service to deeper wells with smaller rigs by using thin-walled pipe with higher strengths than present drill pipe. Although this type drilling has been going on for some time in California, it has been slow to start in the Permian Basin, perhaps because of the severe pipe-wear conditions prevalent throughout the Basin.

One major company is evaluating the use of drill tubing and casing which it has found successful in California.

Based on the findings of those using the tubing in California, a special connection was designed to overcome the major disadvantages of the tubing in use in California. After drilling 21,000 feet of hole with pipe having this special thread, it is believed that the major objections have been overcome.

The joints are easy to stab, have rapid make-up and breakout, and show very little tendency to make up while drilling.

Slower rotary speeds, education of personnel, use of power tongs, and economic incentive may all help to make a thin-walled drill pipe with couplings a practical tool in the hard-rock country.

Pumps. Jet bits have done more to point out the lack of adequate knowledge of pump and rig horsepower requirements than any one item. Everything from large-horsepower pumps and small engines to small-horsepower pumps and large engines could be found. A rig balanced as to drawworks, pump, and engine horsepower was the exception. What actually confused and still confuses most contractors is the vague understanding of what is really required.

The first tendency was to buy large pumps and larger engines. Results presented by rigs boasting 1800 to 2000 maximum horsepower and pumps from 600 to 850 hp were quite impressive until small rigs began to compete with and, in some cases, surpass performance by the big rigs.

Obviously, other factors such as personnel, weight on bit, rotary speed, mud, bit types, and many other variables entered into the picture and to this day it is impossible to evaluate the effectiveness of each.

For West Texas-New Mexico, it is gradually being accepted that the need for large pumps, 600 to 800 hp, is limited and that better flexibility and lower drilling costs can be had with pumps in the 300 to 500-hp class. The smaller pumps are used for jetting in small holes on 5000-foot to

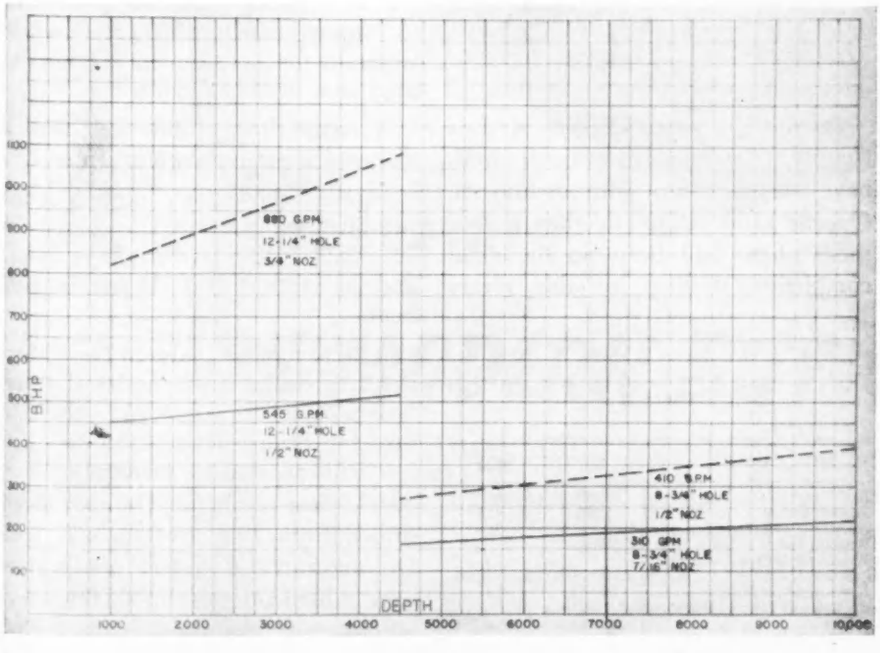

Fig. 3—Comparison of horsepower required for high annulus velocity and low annulus velocity.

Fig. 4—Bottom drill collar melted by fire in producing zone when air drilling.

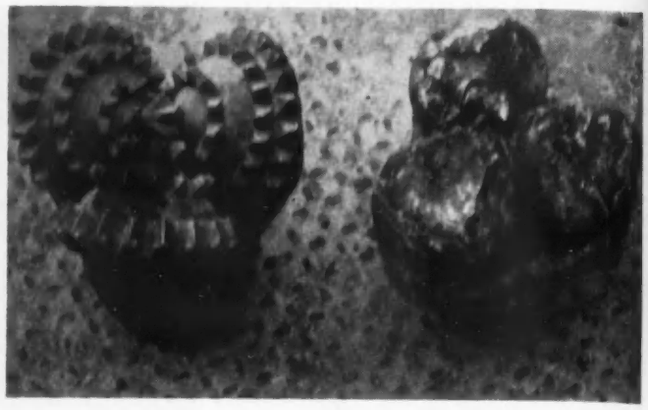

Fig. 5—Rock bits used in air drilling.

7000-foot rigs, and the larger pumps used in parallel on larger intermediate holes then singly on production string holes of deeper wells.

Series compounding of pumps has been done to a limited extent. The parallel application of pumps or overstroking of pumps has been more generally accepted as a means of meeting hydraulic needs. Figure 3 illustrates the horsepower required for jet drilling as originally believed necessary and horsepower used on tests to check feasibility of increasing bit horsepower and reducing annulus velocities to values formerly believed impractical. From this illustration it is apparent that larger-horsepower pumps cannot be conclusively justified for the type drilling found in West Texas and New Mexico.

Air and gas drilling. The practice of using air or gas as a drilling medium has been used to some extent in the Permian Basin. Results obtained through the use of gaseous drilling fluids have been much the same as those obtained in other areas. Water-bearing formations are the major source of trouble, too much water makes it impractical to air lift, and very small amounts of water permits packing of cuttings on drill pipe and hole walls. The latter often results in stuck pipe.

Opinions on what is needed to drill properly with air or gas vary widely. Some operators think 1,500,000 cubic feet per day at 120 pounds per square inch sufficient, whereas others are of the opinion that 3,500,000 cubic feet per day at 1200 to 1500 pounds per square inch will be needed. Obviously, the wide divergence of opinion is due to the varied conditions encountered by those who have tried air or gas drilling. The lower volumes and pressures may be sufficient if depths are shallow and there are no water sands to contend with. Introduction of small amounts of water to further moisten cuttings and prevent sticking may require more air volume, and certainly aerating mud columns will require greater pressures. The many ratios of moisture and gaseous fluids between the extremes of mist and aerated muds presents numerous and varied problems. What is needed, how much improvement to expect, and the ultimate saving will vary as the ratio varies. Just how to evaluate the problem and establish the best practices promises to be even more controversial than the merits of the jet bit in the Permian Basin.

The following cases are selected from some of the operations conducted throughout the Basin area.

In the Caprock Field of Lea County, New Mexico, three wells have been drilled in with air into the Queens sand. Prior to the first of these, there had been no successful completion drilling in with rotary tools using mud in this immediate area.

TABLE 2

	Air	Mud
Hole Size, Inches	8¾	12¼
Footage Drilled	1,293	1,412
Number of Bits	2	12
Rotating Hours	56¼	231½
Weight per Inch of Diameter, pounds	1,140–2,860	2,860–4,100
Revolutions per Minute	65—70	75
Approximate Interval Drilled, Feet	3,100–4,400	3,100–4,500
Volume Circulated, Cu. Ft. per Day	1,900,000	.....
Air Pressure, psi	60—90	.....

The first well drilled in with air was completed as a flowing well. The other two have been dry holes outside the field. On the well which was completed, while drilling into the pay section a fire in the hole was ignited by a piece of burning rubber from the lining of an air hose. The only evidence of the fire at the surface was a puff of white smoke from the flow line. However, the bottom drill collar became hot enough to melt. The fire was extinguished when air circulation was stopped (Figure 4). (See WORLD OIL, February 1, 1955, p. 129).

In another area, southeast of Hobbs, New Mexico, a section of 8¾-inch hole was drilled with air, beginning below the intermediate casing at 3100 feet. Drilling proceeded to approximately 4500 feet where water in the hole forced a return to mud as a drilling fluid.

A comparison of this well with a diagonal offset is shown in Table 2.

Figure 5 shows the condition of the two bits used with air. The one on the left drilled 780 feet in 28½ hours and the other drilled 613 feet in 27¾ hours.

A 3600-foot well, also in New Mexico, was drilled from under the surface pipe to 3277 feet with air. The first bit drilled from 1185 to 2880 feet with an average penetration rate of 60.6 feet per hour. The second bit drilled from 2880 feet to 3277 feet. Drilling rates of 5 feet per minute were obtained with 30,000-pound weight, but crooked hole forced weight to 10,000 pounds. Average penetration rate for six wells in the

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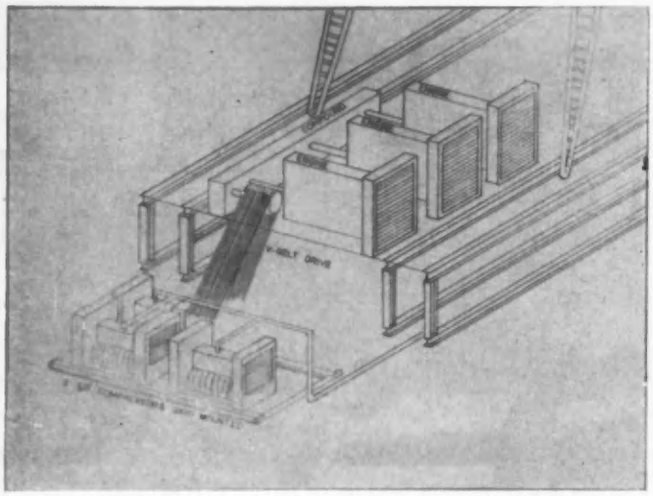

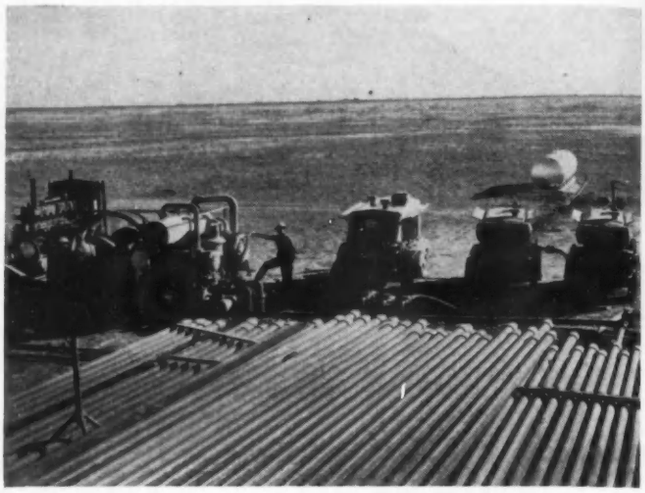

Fig. 6—Air compressor units used in air-drilling operations.

immediate vicinity of this well was 23.3 feet per hour and bits averaged 632 feet for the interval drilled by the first bit.

Four cores cut from 3277 feet to 3364 feet had 100 percent recovery. Difficulty was experienced while coring because of fluid entry into the well bore, and practically no cuttings were circulated while coring and reaming the core hole. Coring on the other six wells using mud averaged 2.5 feet per hour as compared to 11.4 feet per hour on the well drilled with air. The well was mudded up at 3364 feet and cored to total depth.

Two wells drilled by the same company in Val Verde County, Texas, are compared in Table 3.

The gas-drilled hole was handicapped by crooked hole as indicated by the light weights. Despite this disadvantage, the results were very impressive.

The interest that has arisen in recent months in regard to air and gas drilling has prompted compressor manufacturers to alter portable equipment. Two common types are illustrated in Figure 6 with the newer arrangement, on the top, utilizing rig power.

Feed controls. Information on comparison of wells with and without automatic feed controls is limited. One report given by a major company did not find much in favor of the automatic feed controls. However, data compiled by another company shows a marked improvement in average drilling operations through the use of automatic feed controls.

Information on the operations which showed an improvement with use of automatic feed controls has been made available by Humble Oil & Refining Company. The wells are all located in the same field, drilled by the same rig, and employed the same personnel. With such ideal conditions it would be difficult to find more conclusive information than that presented in Table 4.

Little improvement, as shown in Table 4, resulted in the intermediate hole; but in the interval from approximately 4000 to 7100 feet, 16.27 percent increase in penetration was obtained. Wells completed in the lower Spraberry indicate greater improvement in the penetration rate as total depth of wells increased. An overall average improvement of 11.9 percent was obtained with the automatic feed control.

Hydraulic equipment. As the average depth of drilling increases and power becomes more important, power transmission also becomes more important. In order to obtain some of the better features of steam or electric rigs, many new rigs are being equipped with hydraulic couplings or torque converters. Most significant advantages are: 1. engines will not stall, thus preventing lugging at high loads; 2. dampens crankshaft torsional vibrations; 3. engines can be synchronized within slip range; 4. shock loads on power trains are materially reduced; 5. greater flexibility.

Operators report that maintenance on power trains and engines has been materially reduced. One major concern has had a 50 percent reduction in rig repairs, while another has had 50 percent reduction in engine main-

TABLE 3

	Gas	Mud
Hole Size, Inches	8¾	8¾
Footage Drilled	7,251	7,263
Number of Bits	84	154
Feet per Hour	9.25	7.2
Rotating Hours	783.5	1008.75
Weight per Inch of Diameter	250–2,000	4,500–5,700
Revolutions per Minut	70	75
Interval Drilled, Feet	1,510–8,761	1,500–8,763
Volume of Gas, Cu. Ft. per Day	1,500,000	.....
Gas Pressure, psi	75–100	.....

TABLE 4

Comparison of Penetration Rates Feed Control

	Before Installation of Feed Control	After Installation of Feed Control
Surface Hole	7 Wells	10 Wells
Average Depth, Feet	368	361
Average Feet Drilled per Hour Rotating	29.36	32.16
Average Increase in Penetration, percent	....	9.53
Intermediate Hole	7 Wells	10 Wells
Average Interval Considered, Feet	3,642	3,758
Average Feet Drilled per Hour Rotating	44.59	45.39
Average Feet Drilled, per Bit	520.3	463.9
Average Increase in Penetration, percent	....	0.179
Oil-String Hole (Through Upper Spraberry)	6 Wells	10 Wells
Average Interval Considered, Feet	3,988–7,115 (3127)	4,119–7,091 (2972)
Average Feet Drilled, per Hour Rotating	17.94	20.86
Average Feet Drilled, per Bit	175.3	199.5
Average Increase in Penetration, percent	....	16.27
Oil-String Hole (Lower Spraberry)	5 Wells	3 Wells
Average Interval Considered, Feet	3,963–7,999 (4036)	4,201–8,184 (3983)
Average Feet Drilled per Hour, Rotating	15.35	18.35
Average Feet Drilled, per Bit	153.5	151.3
Average Increased in Penetration, Percent	....	19.5

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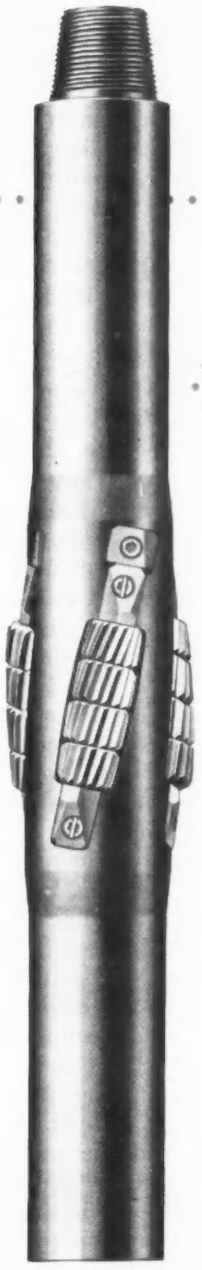

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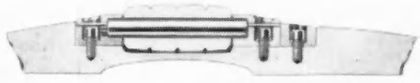

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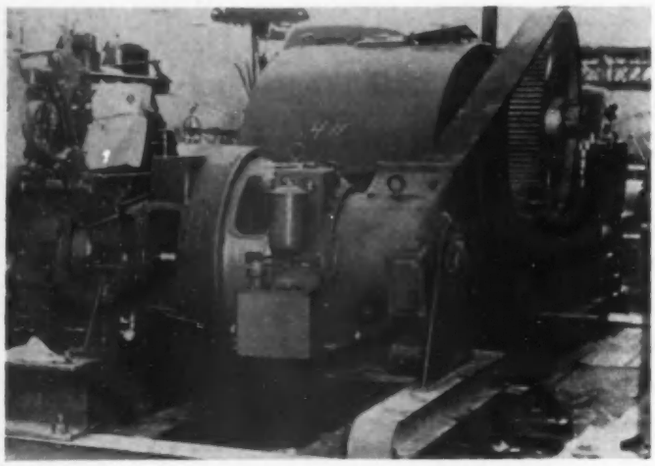

Fig. 7—Torque-converter unit on independently-driven slush pump.

tenance. It is becoming more common to hear reports of compounds running two or three years without a chain failure.

Auxiliary and independently driven slush pumps are using torque converters and fluid couplings. Figure 7. Torque-converter equipped units make it possible for the engines to run at or near governed speeds and the pump strokes vary according to the load. Within certain limits, this reduces the number of liner changes. Care must be exercised not to exceed the recommended pinion-shaft torque.

Transfer of power through fluid reduces the shock loads throughout the engines, power train, and pump. Maintenance costs are materially reduced on engines and pumps when unitized in this manner.

The practice of overspeeding power pumps as a means of obtaining greater hydraulic horsepower than the pumps were designed to handle is also greatly enhanced by using hydraulic drives. An example is presented in the use of a 14-inch pump designed for 255 input horsepower at 65 strokes per minute which, with a flooded suction and fluid couplings, is being used at 90 spm and 350 input horsepower. This pump has over six months service at this load with no ill effects.

Hydraulic motors and pumps have become more widely used as a means of transmitting and applying power. Shale shakers, water pumps, wire line reels, blowout preventers, mud mixers, and other equipment are now being operated by hydraulic power. The use of such power offers protection against fire when drilling with gas, and is flexible in its application. Maintenance costs are reportedly low as compared to other types of power.

One application of particular interest to users of hydraulic power transmission is in rotary table drives. Although limited information is available, it seems that advantages of rotary speed control and predetermined torque on pipe will make this type drive desirable. The extent to which this type drive has been used and developed is still limited to experimentation.

General comparison — 1952-1954. All of the aforementioned developments in Permian Basin practices have had a remarkable composite effect. Table 5 illustrates the change that has come about.

TABLE 5

YEAR	FIELD	INTERMEDIATE HOLE			PRODUCTION HOLE			TOTAL		
		Size, Inches	No. Bits	Days	Size, Inches	No. Bits	Days	Bits	Days	Total Depth, Feet
1952	Townsend	11	20	22	7⅞	98	81	118	103	10,581
1954	Townsend	11	8	12	7⅞	60	37	68	49	10,629
1952	Denton	11	14	14	7⅞	120	84	135	98	12,229
1954	Denton	11	11	11	7⅞	81	57	70	68	12,472
1952	Yarbrough Allen	12¼	6	8	8¾	71	59	77	67	10,719
1954	Yarbrough Allen	12¼	8	10	8¾	69	53	61	63	10,575
1953	Magutex	12¼	14	14	8¾	65	72	79	86	12,570
1954	Magutex	12¼	8	13	8¾	62	62	70	75	12,607
1953	Midland Farms	12¼	16	13	8¾	102	77	118	90	12,654
1954	Midland Farms	12¼	11	12	8¾	63	44	74	56	12,490

The most interesting fact, aside from the increase itself, is the small difference in the Yarbrough Allen field. Both wells were drilled by Humble Oil & Refining Company and employed similar practices. Humble was using oversize collars and heavy weights with jet bits when the first well was drilled. It is evident that they were one of the first to recognize the advantages of such procedures. This example further illustrates what oil operators have contributed to better drilling. The drilling contractors are using these ideas and others advocated by the drilling departments of other companies and are preparing to take a more aggressive part in future developments of drilling technology.

Conclusions. Increased weight on bits to obtain greater penetration has brought about more crooked hole, need of more collars, and greater power to handle the loads. The added power for hoisting has in many cases been applied to jet drilling which also has increased penetration rates. The size pump needed and the proper way to use jet bits is still controversial, but it is generally conceded that pumps in the 200 to 500-hp class will be sufficient for most West Texas drilling.

A more scientific approach to drilling problems, both in application of equipment on the surface and at the bottom of the hole, has resulted in great improvements in drilling time. Continued cooperation between contractors and oil operators is essential to improve drilling practices, and the free exchange of information both individually and collectively through API and AAODC meetings will bring about the needed improvement.

Air and gas drilling, proper sizing of new equipment, use of light-weight drill tubing, and use of new techniques are bringing about reduced costs. As we enter 1955 the many unanswered questions on proper application of drilling tools offers a challenge and promise that better methods and practices will evolve in Permian Basin drilling.

ACKNOWLEDGMENTS

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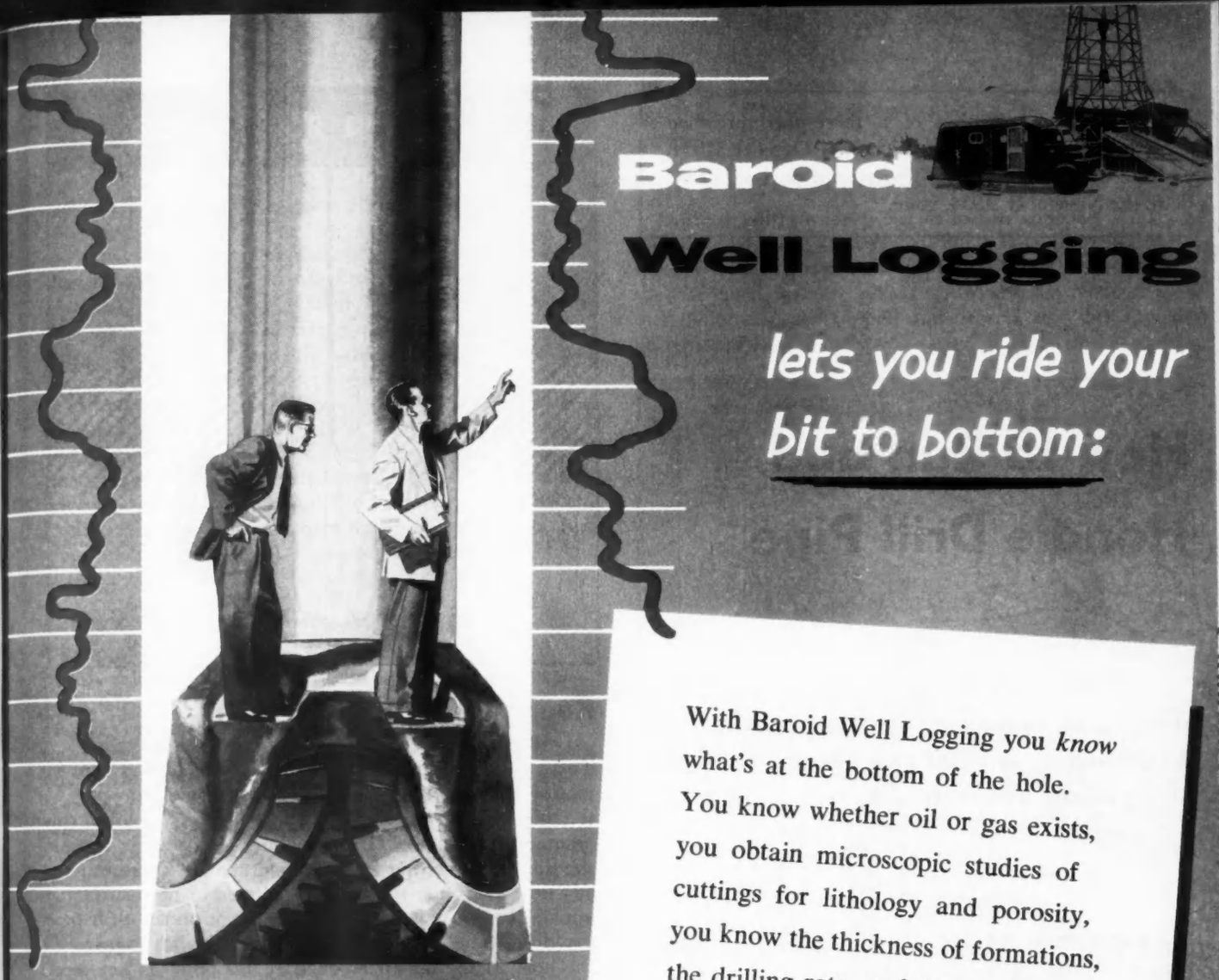
—The End



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How to Run and Handle Drill Pipe

Damage to pipe occurs in field handling and unloading procedures. But just as damaging is what can happen to expensive strings underground.

By RICHARD L. DAILEY, Training Specialist,
The University of Texas, Austin

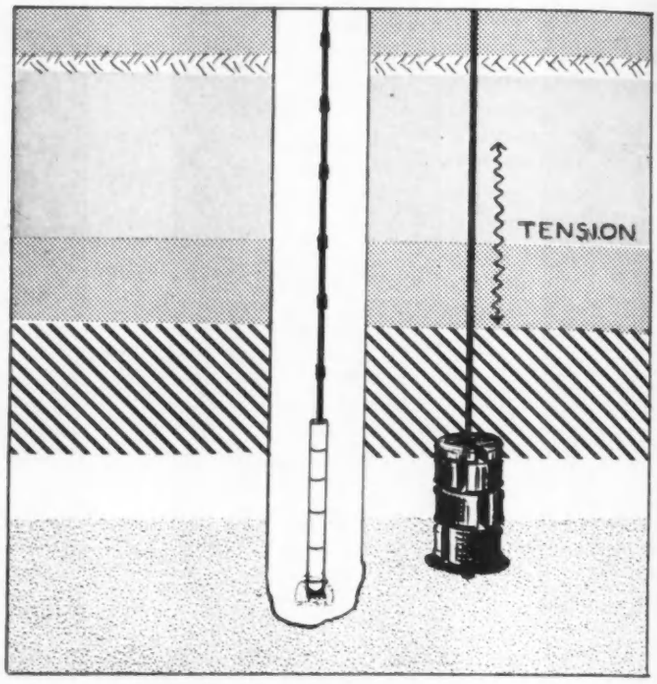
THE FIRST TWO PARTS of this maintenance series discussed field handling, transportation, and unloading procedures where drill string damage occurs frequently. Proper procedures to prevent damage before going into the well were discussed. But damage can occur underground as well as above.

Drillers, toolpushers, and drilling contractor personnel must be constantly on the alert. After the drill pipe has survived its trip to the bottom of the hole, the surface connections which transmit rotation to the pipe must be cleaned and checked. With the kelly on and tightened, the slips are swung out of the way to make a place for the kelly bushing. The slush pumps are engaged to pick up the drilling fluid and send it through the pipe.

Starting rotating slowly . . .

Only now is the drilling string in the position to do the job for which it was intended: carry the drilling fluid to the bottom of the hole and rotate the bit. The kelly bushing is centered in the rotary and rotation of the pipe starts slowly. Starting at high speed snaps the joints—a good way to open fatigue cracks.

A clean working area prevents accidents. It also is conductive to good contractor-operator relations. Meanwhile the driller circulates out the cuttings; sets the weight on the bit . . . and we are making hole.

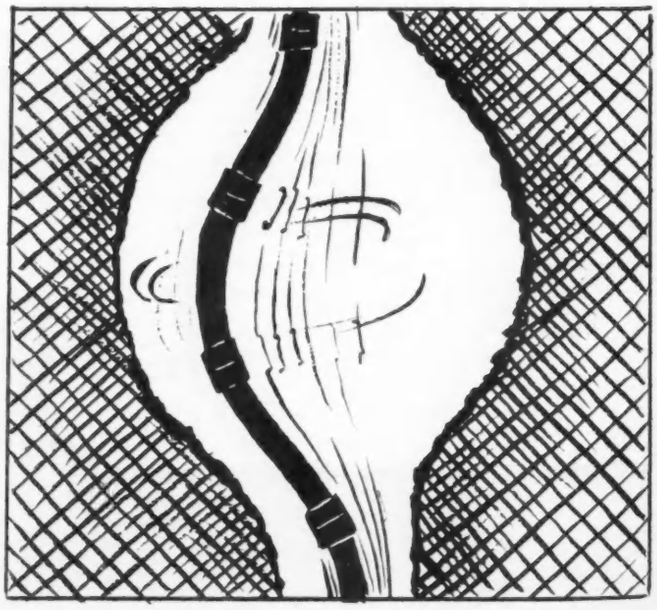


Keep pipe in tension . . .

Drill pipe is limber. It spirals as it rotates under torque. This can be eliminated partly if the drill pipe is kept in tension with only the collars in compression. If any part of the drill pipe is put under compression, the tool joints can become barrel-shaped from rubbing at an angle against the side of the hole. If application of tension does not remedy this, the rotary speed can be altered or hard-surfacing applied to the tool joints. A bright spot on the drill pipe could indicate that the pipe is rotating against the wall of the hole. If the hole is crooked at this point a "key seat" can be forming.

Avoid high rotary speeds . . .

The reverse bend the pipe must make in completing one revolution is often the cause of fatigue. Under tension or compression, high rotary speeds cause the pipe to whip around in large cavities. If the string should part at this



point, it probably would leave a fish that would be hard to retrieve.

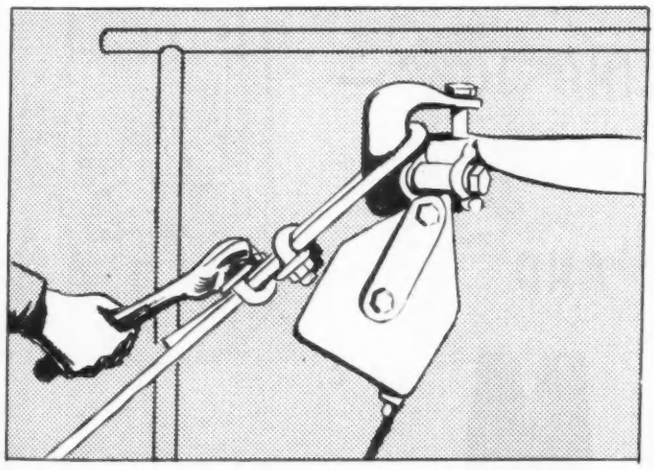
A high spot on the shoulder can cause wobble and sharp threads. Large collars reduce fatigue bending since they are confined more closely than small collars used with same size bit. Some areas are plagued with corrosion fatigue in drill pipe and drill collars. The root of the last unengaged thread becomes pitted. Bending stress is concentrated at this point. A damaged box pin could become corroded beyond use under such conditions. Magnesium rings placed in the bottom of the drill collar box set up an electrical current that resists corrosion. Sodium chromate added to drilling fluid also inhibits corrosion. These abuses of the string underground may not show up at once. But cram and jam the pipe for an eight-hour period and you have cut the string's life by several thousand feet.

Check your handling equipment . . .

Equipment maintenance goes far in preserving the life of the drilling string. Properly maintained equipment also helps safeguard you. Slips should be greased and in proper working order. All moving parts on power slips should be inspected before each trip. Slip dogs frequently fill up with grease and mud. Clean dogs hold better and do not scar the pipe. Broken or worn dogs should be replaced immediately. Standard tooth slip dogs resembling file teeth should not be used. The sharp teeth of the dogs bite into the pipe causing transverse scars which can result in fatigue cracks.

Choose good lubricant thread . . .

Thread lubricant contains a carrier and a soft metal such as zinc, copper, lead, or graphite. It should be kept free of sand and trash. Adulterating a thread lubricant defects the purpose for which it was made. Dope should be the proper viscosity for seasonal temperature.

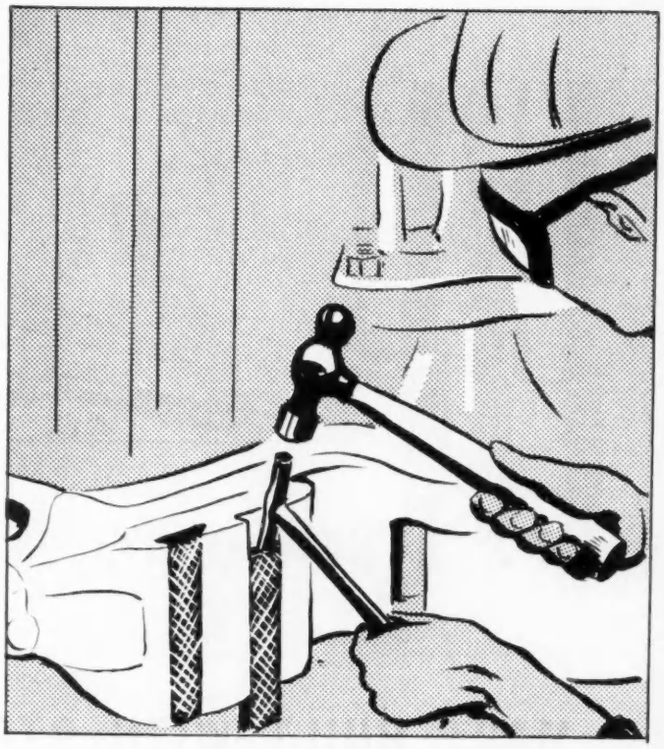


Check snub and jerk lines . . .

Snub and jerk lines should be checked frequently for your own safety. Wickers on the end of wire lines should be seized with friction tape. Wire line clips should be installed correctly with the "U" sides clamping the end of the rope on the short side of the loop. Be certain that the "U" clamp is not reversed as the one shown in the illustration. The "U" side of the clamp crushes and weakens the line. The flat side will allow the short end to unravel.

Dull tong dies injure pipe . . .

Dull and dirty tong dies tend to slip and peel the surfaces of tool joints. Where tool joints have hardened surfaces to reduce wear while drilling, placing the tongs on the hardened surfaces breaks and chips the teeth of the dies. Naturally, all chipped and broken tong dies should be replaced immediately.



Wear goggles when removing dies . .

Goggles should be worn to protect the eyes from flying chips of metal. Many men refuse to wear goggles, claiming they restrict their vision. Then they forget to put on safety hats. A piece of sharp steel can do a lot of damage to an eye. Tools with soft striking surfaces are ideal for removing and installing dies. Some dies are being made with soft ends and a special tooth is available for removing the dies.

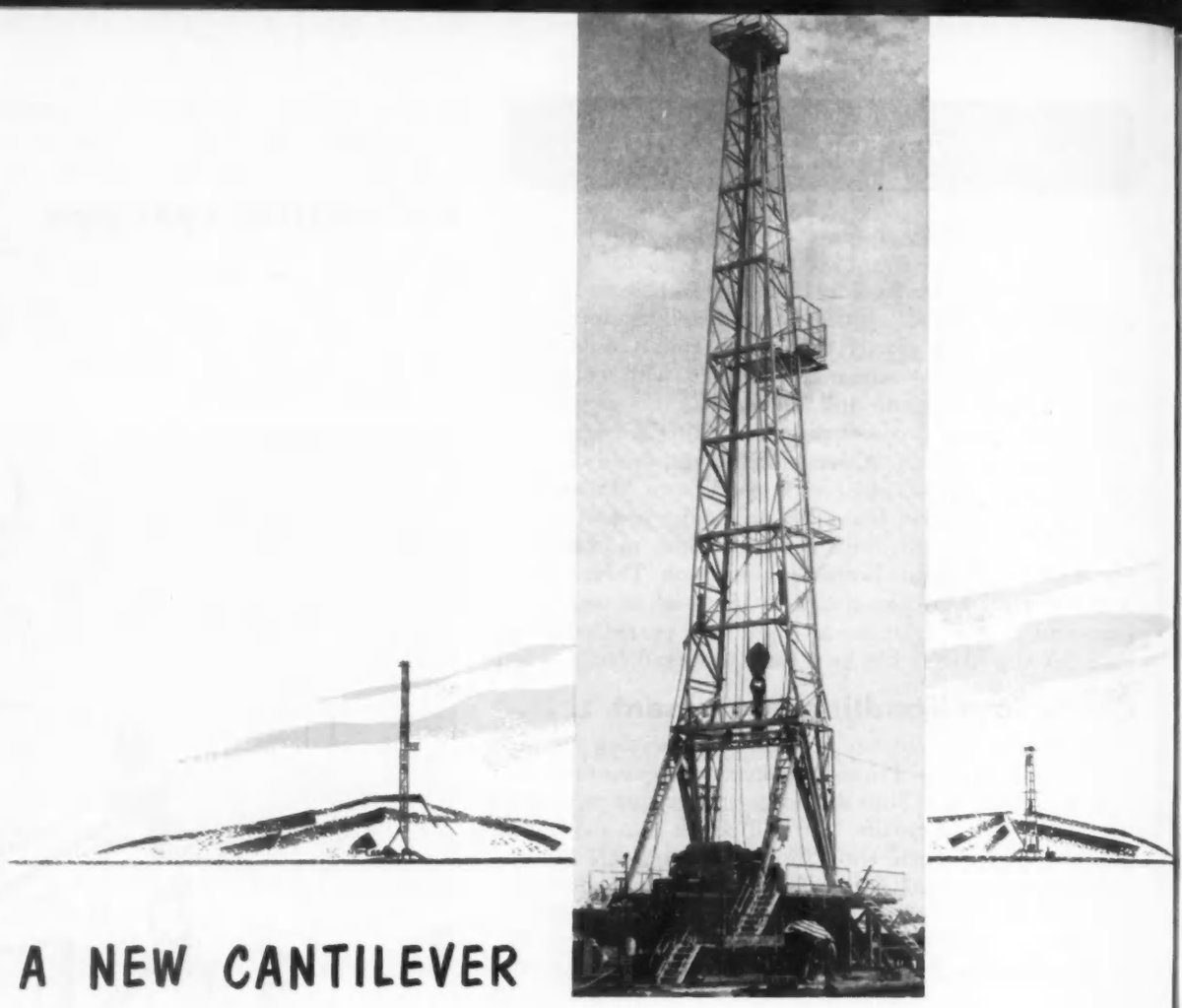
Do not abuse the sub . . .

Injured shoulders and threads on a sub can damage the shoulder and threads of pipe or collars. Subs should be inspected and kept in excellent repair. After a sub is broken out, it is often tossed aside without regard for damage when it strikes the floor or another object.

Let's make a trip . . .

While drilling, everything is put in readiness for the trip out of the hole. Equipment inspected, greased and repaired. Sufficient thread dope for pipe and collars is on hand. The floor is cleared for action. The bit is dull and it is time for a change. So, out of the hole we come. Handling the drilling string coming out of the hole is much like going into the hole.

Continued on Page 91



IT'S A NEW CANTILEVER

MAST BUILT WITH STRENGTH TO SPARE

FOR TOUGH, DEEP DRILLING JOBS—

IT'S RUGGED, EFFICIENT AND

COMPLETE . . . . . .

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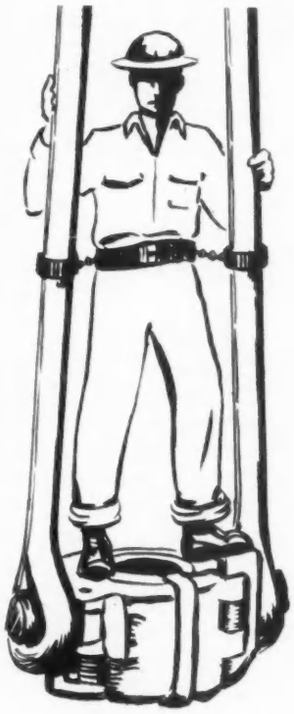
CARING FOR DRILL PIPE

However there are certain aspects that should not be overlooked. The first job is to wash down the kelly, break it out, and, with the aid of the cathead, pull the kelly and swivel over to the rat hole where they will be stored until the new bit is back on bottom.

The safety latch on the hook is opened and the hook is lowered away from the swivel bale, leaving the elevators hanging free. The elevators then are inspected to see that they are in proper working order. A pipe wiper is installed in the rotary table to wipe the drilling fluid off the pipe as it comes from the hole. Pipe slick with mud is dangerous and cumbersome to handle. The rubber wiper is placed on the pipe over a special sub and pushed down with the elevators. Since the wiper is to be stationed beneath the rotary bushings, the bushings must be removed.

Again the cat line comes in handy. It lifts the heavy bushings out of the rotary and onto the floor leaving an opening large enough for the wiper to pass through. The rotary table also may be opened in this manner when large bits are used. The wiper then is pushed down the pipe and into position and the bushings are replaced. If automatic slips are used, they are set into position and the access slot is locked into place. It is now time for the derrickman to take his place on the monkeyboard.



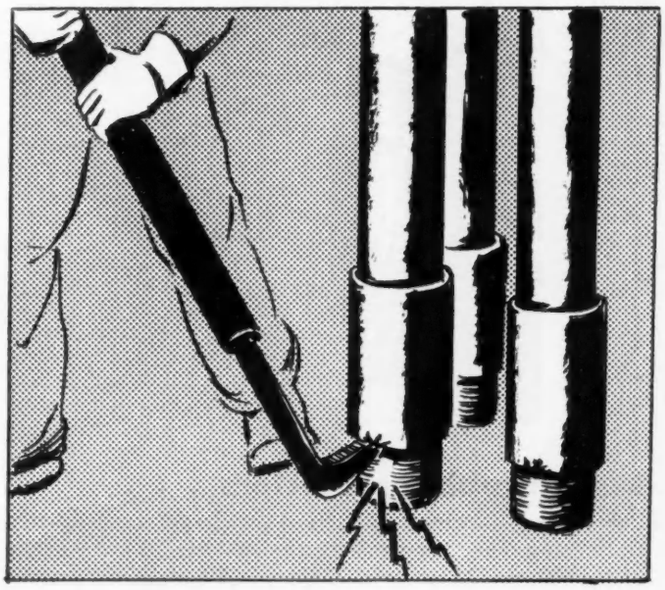
Derrickman takes his place . . .

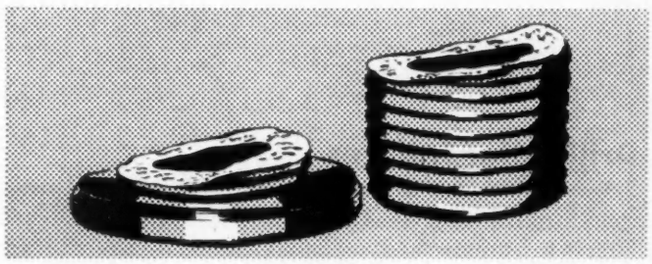
Some companies require their men to climb the derrick. Some states require that the ladder be staggered at each girth and enclosed in cages or guards. Some derrickmen ride the elevators with safety belts attached around bales. The pipe is doped . . . the blocks come down . . . elevators are latched on . . . slips are pulled . . . and the stand is started out of the hole.

Breaking-out tests driller's skill . . .

A pin is bounced off a box. This means trouble unless something is done to remove the dent from the shoulder. A circular file is used to remove the dent. The steel cuttings are removed so they will not interfere with the seal when the pipe is made up next. There is a right and a wrong way to use these facing tools.

In order to rotate breaks, it becomes necessary at times to lay down one or two joints of pipe. Instead of using the cat line and mouse hole in the process of getting the joint out of the V-door, the pipe is run out on the walk and released directly from the elevators.



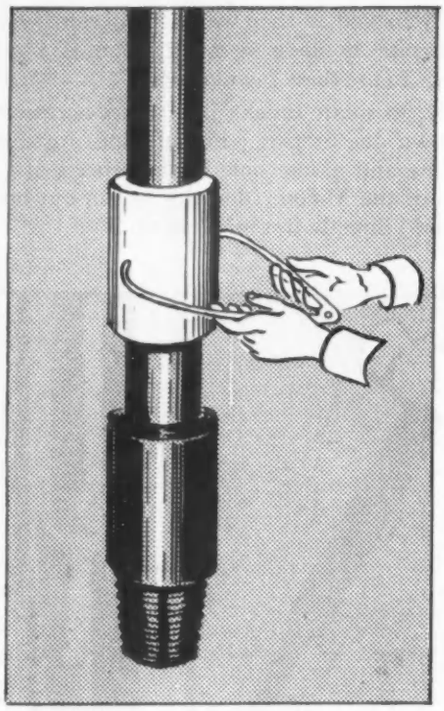


Laying back a stand . . .

This operation calls for coordination between the driller and crew since the block and elevators sometimes weight down one end of the pipe and when the pipe drops, severe damage can result. On some rigs they are not so careful about the pipe, especially when lining up a stand of drill pipe. This homemade jack could have caused considerable trouble. If a jack were used that would support the shoulders on a large surface bearing instead of the shaper edge of a discarded pipe wrench, it would leave the sealing surface unmarred.

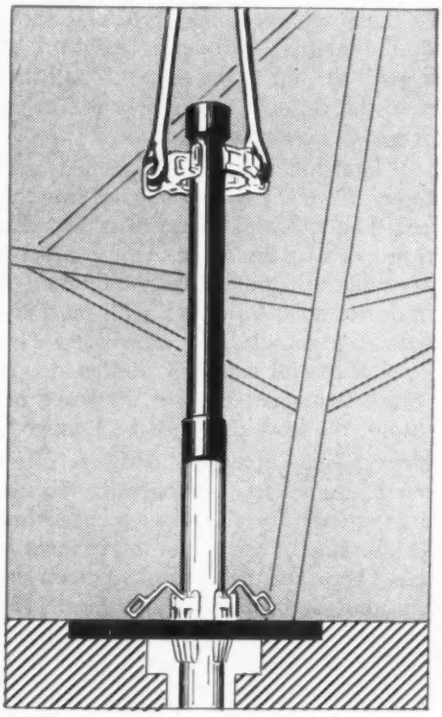
The only seal against washouts on pipe and collars are the shoulders. The scar left by wrench jaw broke the seal and when the pin was broken out it was dry. Furthermore, raised metal bordering the scar caused the pin to wobble and crack.

CARING FOR DRILL PIPE



Inspect rubber protectors . . .

Rubber protectors on drill pipe should be calipered frequently. They keep the pipe from wearing holes in the casing. The rubber protectors should be placed on the pipe so as to give maximum protection to the casing and should be the proper outside diameter.



Use a lift sub . . .

A lifting sub is put on top of the drill collar so that the elevators can carry the collar into the derrick. It first is made up hand tight and then tonged so there is no danger that the lifting sub will jump the threads when the stand is pulled up into the derrick. Unlike drill pipe, which is subject to twist-offs as well as tool joint failures, practically all failures in drill collars center around the pin and box.

Drill collar failures . . .

Box failures can be contributed to corrosion and stress concentration fatigue. Pin failures can be contributed largely to various handling and operational factors. Many failures can be caught and remedied before they reach the point where the string parts and a fishing job results. Alternate joints should be broken out so that they can be inspected for dry pins, washouts, injured shoulders, or evidence of corrosion fatigue and pending twist-offs. Many of these can be caught by a quick inspection as the joints come from the hole even though the break will come at a different place. On deep wells sometimes outside inspection services are obtained to detect any flaw or defect in the pipe and collars that might have occured while drilling.

To keep from galling and jumping the threads, drill collars should be spun out slowly and only enough tension should be put on the hook spring to carry the stand. Finally the drill collars should be lowered slowly onto the floor so they will not buckle and bend as they hit the mat.

Laying down drill pipe . . .

With the hole made and cased, the drill pipe has to be laid down. A more elaborate setup now can be used to lay down the string. (See October, 1954, WORLD OIL, Pages 142 and 144). The most common practice is to use a hook and trolley. Some contractors have been considering using a hook similar to the "V" type used in unloading freight cars. Be careful. DO NOT HIT THOSE THREADS.

The drill collars hamper this operation with their weight. On some rigs the trolley lines are attached to the cat line for hoisting the pin end of the collar off the walk. Since the cathead man can not see the walk from where he is standing, the pin often digs into the walk creating a hazard to the pin and shoulders. The use of protectors to protect the threads and shoulders also has been mentioned previously. Protectors can be used to as much or more advantage in laying down as picking up the drill string.

Using a loose trolley line makes it necessary for the carrier block to be carried back to the floor. Whereas a stationary trolley line allows a weight to retrieve and return the block. A string that has drilled through corrosive formation such as salt can be protected by washing down thoroughly before being stored or transferred. This pipe represents thousands of dollars. It should be taken care of.

—**The End**

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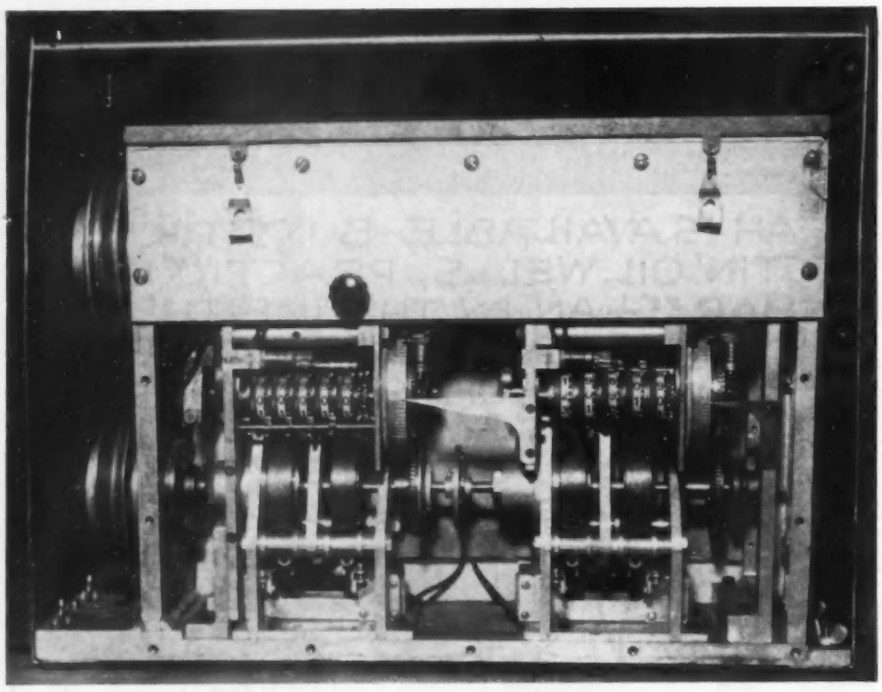

SIGNAL-PRODUCING EQUIPMENT includes arrangement of micro-switches and disc elements that gives total depth count foot by foot.

New Depth Chronometer . . .

. . . compiles drilling data miles from the rig—accurately and automatically.

A NEW DEVICE that will compile rate-of-drilling data accurately and and automatically has been developed by Thomas A. Banning of Chicago. Expensive early morning telephone calls to report drilling progress often tie up the drilling superintendent and his toolpushers. These can be eliminated by an instrument in a 35-pound carrying case that can be placed in an office miles from the rig.

This instrument completely eliminates manual responsibility and gives a precisely accurate record of all drilling operations.

An additional advantage provided by this new equipment is its adaptability to transmission of signals to the recording equipment by wire or radio. This will enable the location of recording equipment in the central office of the drilling company, or in any other place at any distance from the derrick. Thus, a ready record is available at anytime at the most convenient location.

If desired, 2 or 3 recorders may be actuated by the single signalling unit. These recordings may all be in logged form, or one or more of them may be tabular.

A time distribution chart can be produced concurrently with the other records so that management will have detailed information of the minute-by-minute progress of a drilling operation at all times. The elapsed time between every movement, such as making connections, round trips, circulating, surveying, sidewall coring, wire line coring, tour changing, repairs, fishing, time out, and other drilling operations will be recorded.

The signal-producing equipment includes an arrangement of micro-switches and disk elements that can give a total depth count foot-by-foot, or can be read directly in hundredths of a foot.

Clutches automatically control the mechanism during off-bottom adjustments without interfering with total depth logging and prevent any backup movement of the total depth counter.

A dead-line attachment may give a signal, when returning to bottom, at the exact load condition which existed when going off bottom to ensure even bit pressure and drilling string adjustment.

Possible errors of signalling "loaded" and "unloaded" due to stiffness of the 1¼- or 1½-inch cable of the drilling tackle setup or possible "freezing" of the last pulley at the crown block may be eliminated by a strain-gage arrangement.

The recording instrument includes either log producing records, tabulating units, or both. Each of these units is self-contained, and even when a duplicating log recorder is used, it may also be self-contained.

In the log-producing recorder, which gives the conventional tracing, provision is made for changing the time values across the log for either 5 or 10 minutes per inch across, and for changing the depth spacings for either 1, 2, or 5 inches per hundred feet of drilling. Simple finger tip operated buttons or remote control will effect these adjustments.

A time counter, regulated by an electric pulse of measured frequency is delivered by an electrically operated clock. Changes of pulse frequency will readily adjust time rate indications across the log as desired.

Separate traces for the various categories into which the total time is divided are produced by a time distribution chart.

The simplicity of installation is another improvement provided by the Banning Depth Chronometer. Conventional electrical cable plug-in connections between the signalling unit and recorder can be made in a very short time.

No attention need be given the equipment during normal drilling. When making a round trip, the operations will also be fully automatic until the bit is close to the rotary table. Then a signal will be given that automatic operation discontinues. It is only then that manual controls of simple form will be used.

Tests of a pilot signalling unit on a drilling well have indicated an accuracy of closer than 1 foot in 10,000.

—**The End**

World Oil Graphics

Drilling Engine Fuel Care

Do not attempt to reclaim, as rig engine fuel, diesel fuel salvaged from other containers.

Avoid possible fouled-up fuel injectors by storing salvaged fuel in separate tank; use as cleaning fluid or solvent.

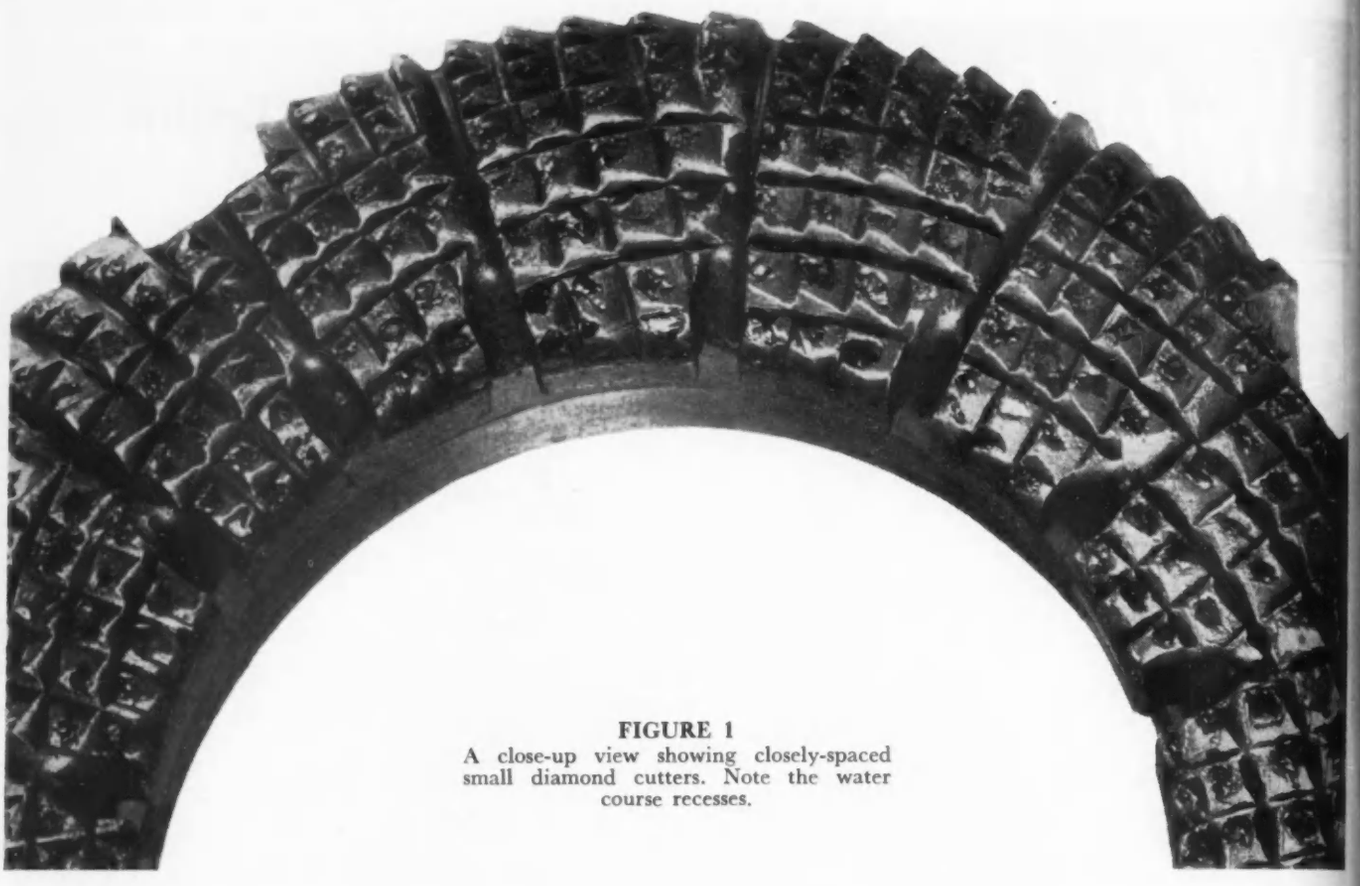

FIGURE 1
A close-up view showing closely-spaced small diamond cutters. Note the water course recesses.

How to Get Most Out of Diamond Bits

The diamond bit is an important drilling tool. A proper understanding of the principles of bit action will help achieve maximum efficiency.

By ED B. WILLIAMS, JR., President,
The Williams Bit & Tool Company, Greenville, Texas

THE DIAMOND BIT is a shear type bit. The diamonds penetrate into rock when rotated. Unlike the fishtail or other blade type bits which cut with shear action, the diamond bit must be operated within much narrower limits than metal bits using the same cutting action.

If diamonds were substituted for the tungsten carbide slugs in a fishtail bit to provide a combination of characteristics for drilling hard sand beds, etc. within thick shale sections, the results would be negative. Failure of the diamond would occur after a short time in the relatively soft shale. The life of diamonds when hard sand is encountered will be considerably shorter than in soft shale. Diamonds are not suitable as a cutter when the operating conditions are this extreme.

To understand this condition it should be pointed out that the carbide slug and a vertical portion of the cutting edge of the fishtail blade while cutting is blocked off from the circulating fluid by the contact with the formation and extreme surface temperatures are produced on the slug and cutting surface of the blades. This temperature is too great for the diamond, not considering the normal impact load involved, and would result in failure of the diamond.

The impact load on carbide slugs is a variable which depends in part on how near the bit is rotating on its center, the rigidity of the drill collar section, and the rate weight is applied. Diamonds exposed in this manner fail almost immediately. Diamond breakage tests have been made to determine the ratio of exposure of a diamond to its beam-loading or shear strength. Its strength remains relatively high until exposed to approximately 1/3 of its diameter. Additional exposure reduces its strength astonishingly fast.

Bethlehem M-58

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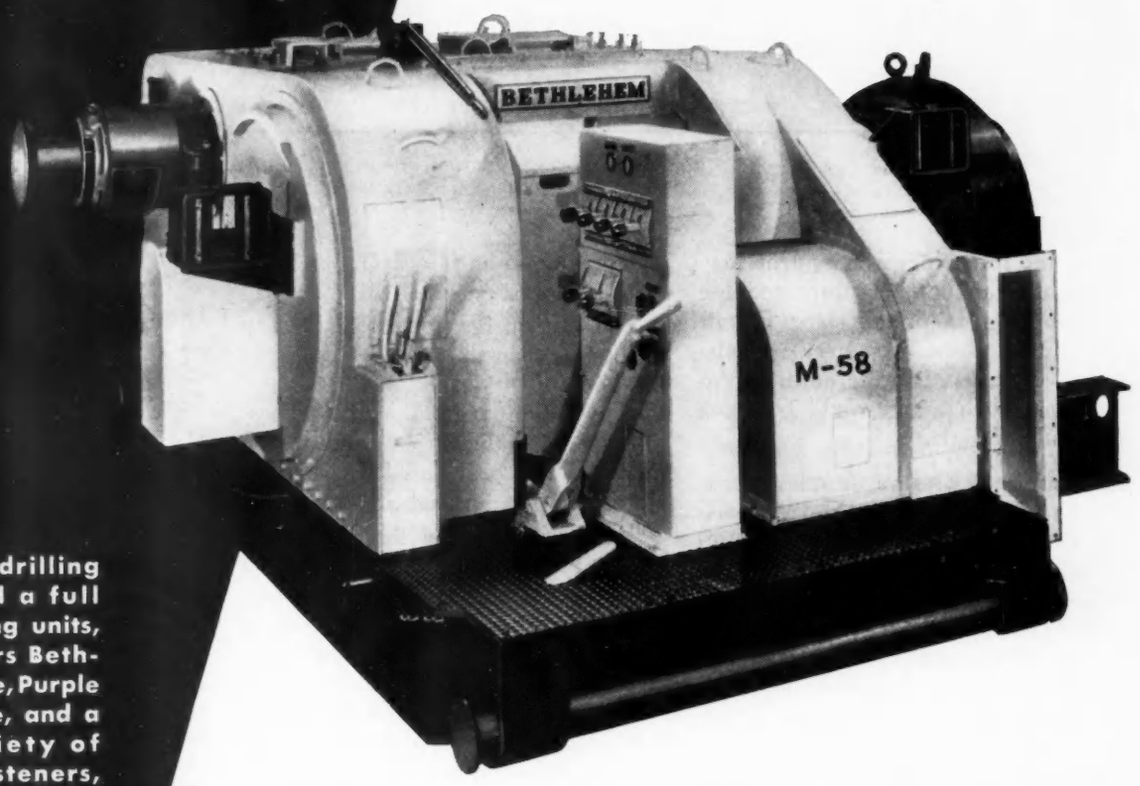
a rig with the optional features most in demand



In addition to drilling equipment and a full range of pumping units, Bethlehem offers Beth-Co-Weld line pipe, Purple Strand wire rope, and a complete variety of sucker rods, fasteners, etc. Ask for these products when equipping your oil-country installations.

For jobs of medium depths, you'll never find a more powerful rig than Bethlehem's M-58. It's a drawworks with short, strong shafts, heavy chains, big brakes, and high clutch capacity (59,000 ft-lb in the low-speed drum clutch). There's extra power, extra strength, in all the vital working parts, yet nothing is burdened with excess weight.

Though strictly a heavy-duty unit, the rig is very compact and is easy to move from job to job. The engine compound is of sectionalized type, so that the outfit can readily be broken down into loads of required road widths.

Many applications require a drawworks with an upper drum, and we now offer this equipment with the M-58. The upper drum, however, is strictly an optional feature; one you can specify or not, as you choose.

Speaking of optional features, there are several other good ones. The choice of drives, for instance. The M-58 is offered with regular mechanical drive, with fluid coupling, or with torque-converter. The unit also permits its owner complete latitude in the choice of engines and engine combinations.

Why not investigate these and other advanced features of the M-58? Our nearest office will gladly furnish full details.

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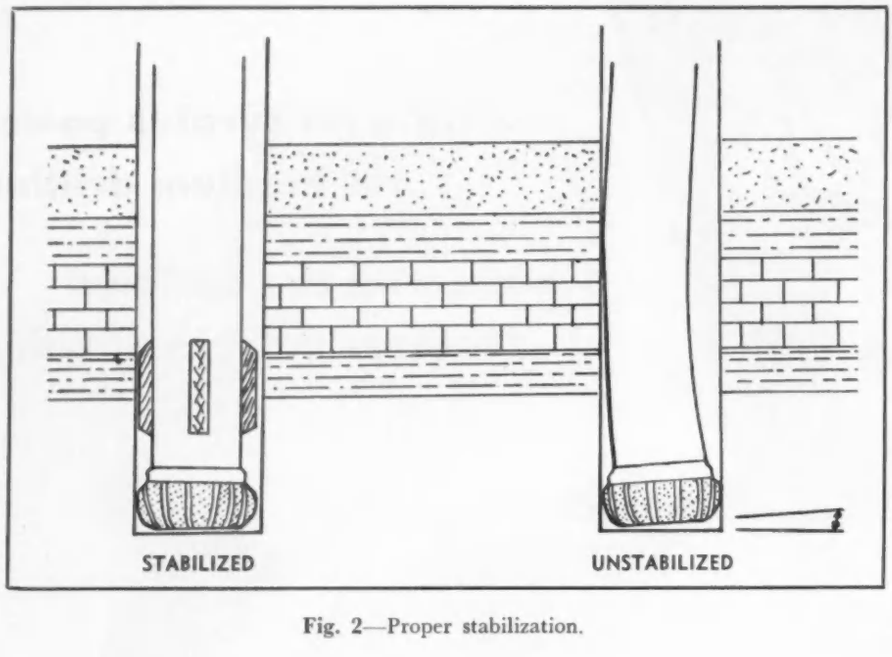

Fig. 2—Proper stabilization.

From the foregoing, it is evident that diamonds can not be substituted for carbide slugs in present type fishtail bits. But, if these two adverse conditions were altered to the limits of the diamond, such a bit would be commercially possible.

In diamond bits, a standard procedure of reducing the impact loading of diamonds is to distribute the total load over more diamonds. Therefore the impact on the individual diamond is reduced and, in like manner, the depth cut and the heat unit per diamond is reduced proportionally.

The reduction of the heat and impact load per diamond in this manner introduces the problem of keeping these small, closely-spaced cutters clear of the cuttings they produce. A bit can continue to operate only if the cuttings are removed at the rate they are produced. (Figure 1)

Diamond coring of shale or similar characteristic rocks are usually slow and trying on the operator's nerves. Although not hard, the shale does not easily clear the closely-spaced diamonds and usually too much weight is used on the bit. This aggravates rather than helps the cutting action. Shale and a few chalks and limestones, in the the presence of water base muds, do not chip or shear readily from the diamond action. They are removed as a gummy mix. This mix has a tendency to fill up the diamond area between fluid grooves. This retards the cutting of additional hole in the same manner a fine-tooth file cutting lead or aluminum fills up between the teeth and ceases to cut.

The friction developed on the face of the bit when thus filled depends on the amount of weight on the bit and the revolutions per minute. It is possible to burn these cuttings into the metal of the bit. This can result in either complete or high diamond loss.

The basic cause of the over-filling of the diamond area is that the bit cuts faster than the circulating fluid can remove the cuttings. The usual procedure of increasing the circulation normally corrects the lagging of the cuttings in the diamond area but is usually over-corrected and the excess fluid restrains the diamonds from performing their full cutting action. Optimum footage results when the correct amount of fluid is passed through the bit allowing the diamonds to be in proper contact with the bottom of the hole and cuttings to be removed properly.

Velocity of the circulating fluid is important to effective diamond drilling as the most effective part of the circulating fluid washes across the diamond area. This generally is referred to as the "pressure drop" on the bit. The difference in total pump pressure when the bit is on bottom and off bottom without altering the operating pump RPM is the pressure drop across the bit. This represents the pressure needed to force the fluid through the diamond area to remove the cuttings and cool the diamonds. If it is less than recommended pressure, the pump should be adjusted to give the pressure drop within its best operation range.

As a rule, for most sizes of bits with water base muds of 9-10 pounds per gallon, and viscosity of approximately 40 seconds, the following pressure drops are adequate for most holes in which there is shale to be cut.

FOR SOFT FORMATIONS

	Pres. drop
Small stone bits	125-175 psi
Medium stone bits	100-150 psi
Large stone bits	75-125 psi

FOR HARD ROCKS

Small stone bits	100-150 psi
Medium stone bits	75-125 psi

Although the above pressure drops are best for the bit operation, if these volumes do not coincide with the hole requirements, adjustments in the amount of fluid should be made to take care of particular hole requirements.

The pressure drop is caused by the bit being engaged on the bottom of the hole and forcing all the flow of fluid through the relatively small grooves of the bit. This results in an increase in the velocity of the fluid through the bit. Immediately after the fluid has passed the constriction area of the bit, the velocity returns to normal.

Stabilization of the bit greatly affects its cutting action and the effectiveness of the circulating fluid. Proper stabilization for the bit is defined as the center line of the entire length of the core barrel being the same as the center line of the section of hole it is operating in.

When the bit is stabilized properly as defined above, it works within all its predetermined limits. An unstabilized bit loses some of its control of fluid flow and depth of cut by the diamonds (Figure 2). When the bit is rocked on bottom, one side will be lifted in relation to the opposite side. This forces over-cutting of the diamonds on one side and also allows or provides additional fluid area because it face is not flush with the bottom of the hole, and results in a drop of the velocity across the bit. As a rule, a decline in drilling rate results and the life of the bit is effected.

The path of the bit is reflected on the outside diameter (Figure 3) of the core. Uniform undersized core indicates the bit has been rotating off-center. The threaded, ridged or

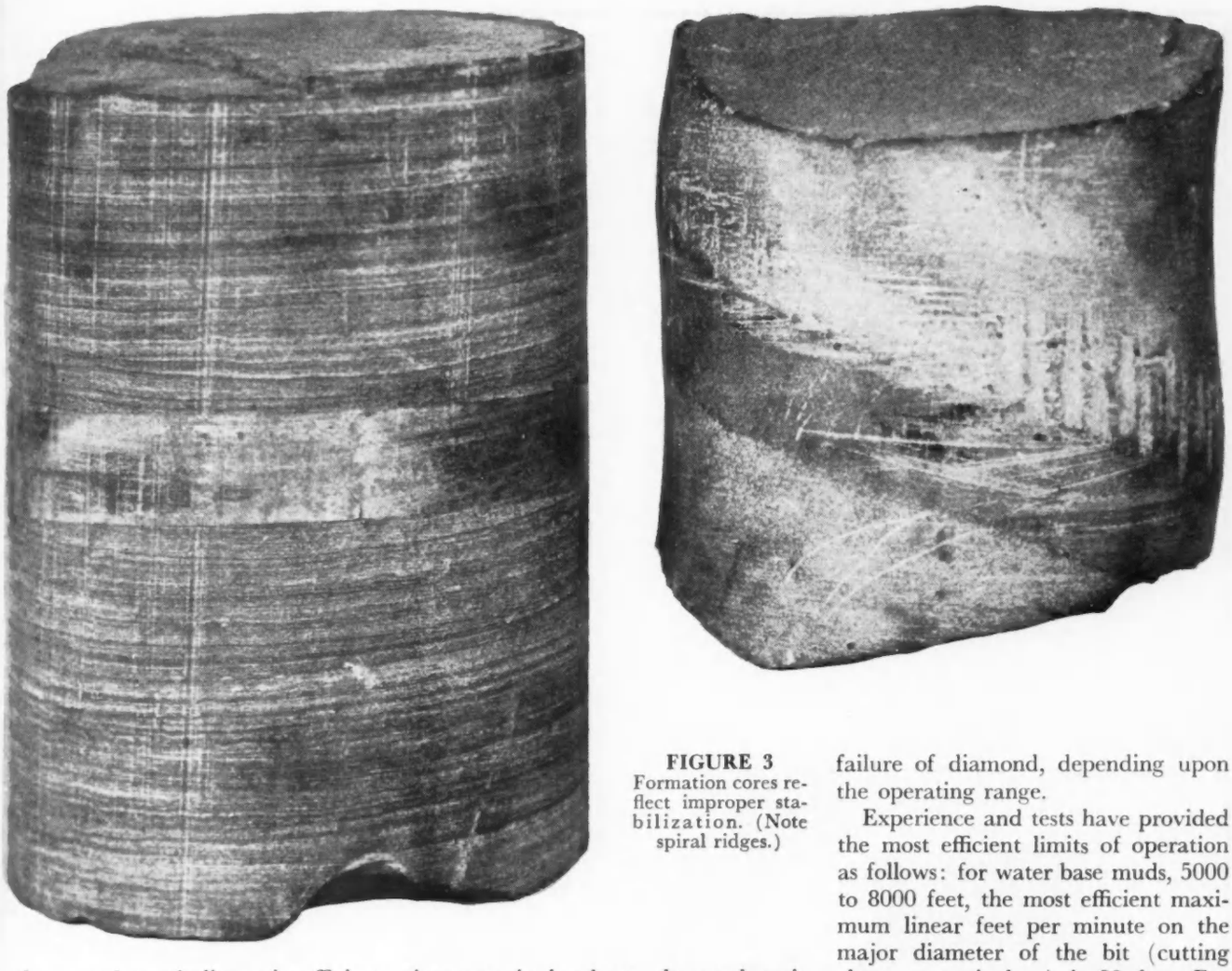

FIGURE 3
Formation cores reflect improper stabilization. (Note spiral ridges.)

cork-screwed core indicates insufficient stabilization in which the direction of the bit has been deviated from the centerline of the hole. The amount and frequency is reflected as the pitch or number of threads per feet and the depth of the thread on the core. Improper or insufficient stabilization of the core barrel, bent drill collars, undersized drill collars, overweighting of the drill collar or core barrel section can cause compression bends in any of this section. The amount and position of the bend determines the influence it will have on the bit.

Proper placement of stabilizers on a 50-foot core barrel—one immediately above the bit, the second approximately 25 feet above the bit, and the third at the top of the core barrel, eliminates the bending or deflections in the core barrel for most operating conditions.

In hard rock coring such as hard sands, chert, quartzites, etc., the diamond bit should be operated under slower RPM and, hole conditions permitting, less pressure drop and at a governed penetration rate. As the rock increases in hardness, the work unit performed per diamond per foot of hole increases. The development of impact loads becomes a paramount factor in the performance of the diamond. Stabilization is needed more vitally, and a governed penetration rate becomes a necessity. As the bond of the rock increases in hardness, the diamond must be subjected to a higher psi pressure to fracture or break this bond. Under this increase of pressure the heat transfer to the diamond becomes greater and in order not to exceed its temperature limit, the time unit must be increased proportionally by decreasing its penetration footage per minute as the rock increases in hardness.

When diamond breaks the bond of harder rocks such as quartzite, chert, etc., the sequence of full to practically no loading occurs. The full load is instantaneous with the failure of the bond of the rock. After failure, the load drops considerably and increases intermittently to full load again. This type of impact loading on the diamond is severe and sometimes causes failure of diamond, depending upon the operating range.

Experience and tests have provided the most efficient limits of operation as follows: for water base muds, 5000 to 8000 feet, the most efficient maximum linear feet per minute on the major diameter of the bit (cutting chert or equivalent) is 90 feet. For depths to 14,000 feet, it is 80 feet.

Excess linear speeds cause premature breakdown of the diamonds and it is advisable to operate slightly under rather than over these speeds. If oil base muds are used, the above range can be safely increased 10 percent.

Good drilling practice is a function of the desirable RPM, and addition of the proper amount of weight to cause desired diamond penetration. On a new bit the weight required to get this penetration will start near 250 pounds per square inch and as the bit progressively breaks down, the weight should be progressively increased to a maximum of 500 psi. Only in rare isolated cases has weight exceeding this limit proven economical.

It is advisable to maintain a governed drilling rate in this type rock, especially if it is fractured or occurring as nodules, etc. In drilling rates exceeding three feet per hour, the heat and impact load on the diamond is in the critical range and its life will be shortened proportionally.

—The End

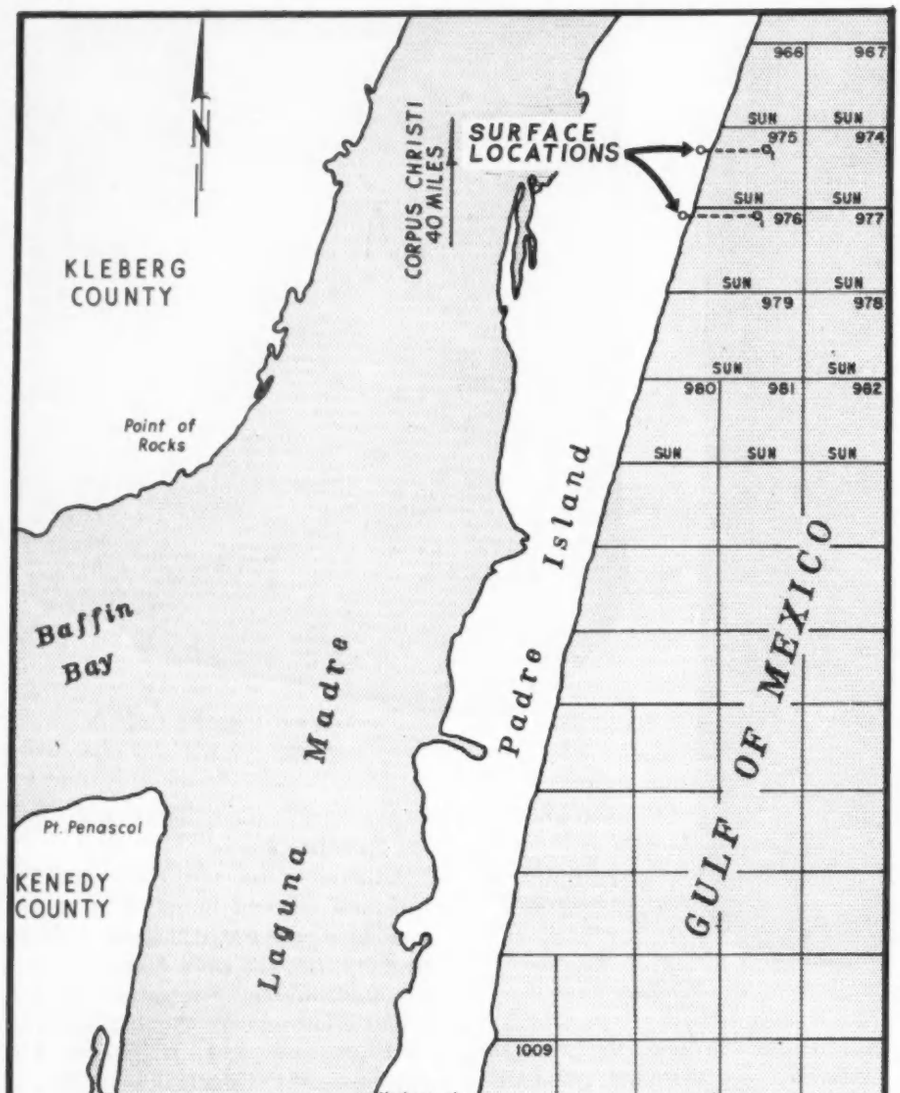

Fig. 1—Sun Oil Company's surface and bottom-hole locations in Gulf of Mexico leases off Texas coast.

Sun Reports on Successful Directional Drilling Jobs

They accepted calculated risks by drilling medium high-angle wells from an island. The money saved over offshore drilling in 45 feet of water was worth it.

By J. E. EDISON, Petroleum Engineer, Sun Oil Company, Corpus Christi, Texas

To TEST a Marginulina sand structure underlying a portion of the lower Texas Gulf Coast, Sun Oil Company recently drilled three relatively large-displacement directional wells from Padre Island out under the Gulf of Mexico. While the hazards and limitations involved in drilling medium high-angle wells were recognized, the cost advantage of a successful directional campaign, as compared with other methods of drilling in the 20 to 40-foot waters of the Gulf, made the calculated risk well worth accepting.

The three wells, State-Gulf 1018-1, 976-1, and 975-1, are located approximately 40 miles south of Corpus Christi; Figure 1 is a large scale map of the area showing the surface and bottom-hole locations. Figures 2, 3, and 4 are horizontal and vertical plots of the proposed and actual courses of the wells. Pertinent data such as the maximum angle, length of deflection, rig days, etc. are given in Table 1.

Planning. The success of this directional drilling program must be credited in part to the careful and extensive planning which preceded the operation. Initially such planning was based on information gathered from other operators, directional control specialists, drilling contractors, drilling mud engineers, and manufacturers of surveying instruments and special tools. A review of the literature on the subject was conducted. Data thus gathered was discussed at several conferences of company personnel and the drilling contractor and directional specialist chosen for the well. Specific and detailed plans were formulated at these conferences. Once directional drilling was started, the experience gained on each well was evaluated and plans for the subsequent well were

TABLE 1

WELL NUMBER	1018-1	976-1	975-1
Measured Depth, Feet	9209	9238	9324
Vertical Depth, Feet	7932	7900	8331
Horizontal Displacement, Feet	4341	4493	3920
Maximum Angle, Degrees	43½	37½	31½
Days Drilling*	32	40	42
Number of Whipstocks	7	3	5
Surface Casing (10¾"), Feet	1993	3102	3002
Production Casing (5½"), Feet	9209	9230	9324

* Includes casing and coring operations, but not completion or rig up.

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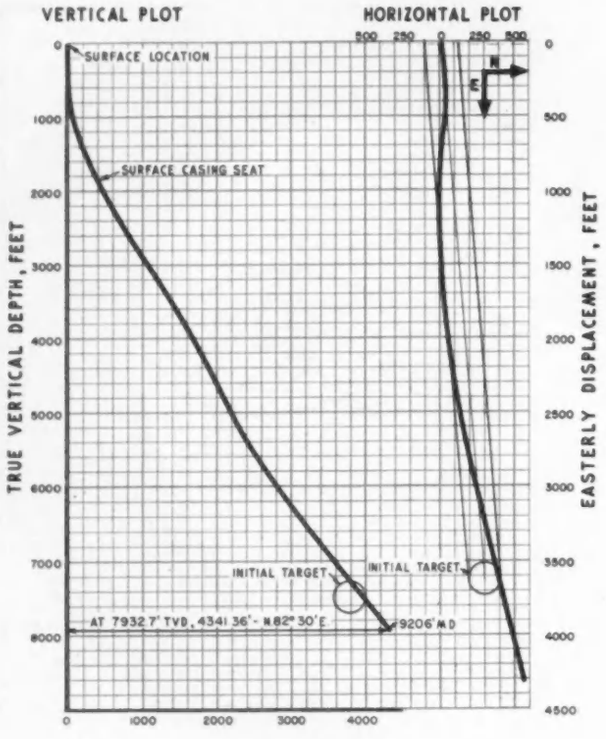

Fig. 2—Sun Oil Company, State Gulf 1018-1, Kenedy County, Texas.

based on the sum of knowedge thus gained.

A number of the factors considered and the decisions reached were as follows:

1. Selection of Directional Drilling Company. A competent and experienced directional control specialist is of great importance, and the selection of the drilling specialist warrants serious investigation and consideration. From a number of well-qualified individuals and organizations, Sun selected a concern because of its greater experience in the immediate area.

2. Study of Rig. The problems inherent in any directional well demand better-than-average rig, crews, and rig supervisory personnel. After careful study, paticularly of the hoisting and pumping equipment, a 10,000-foot rig owned by Brewster and Bartle Drilling Company of Houston was selected, and the contractor was requested to make certain changes in the hydraulic system. Previous experience had proven the rig personnel most satisfactory.

3. Target Tolerance. Ordinarily the larger the bottom-hole target, the simpler is the directional control problem. The size of the target is often determined by geological considerations or by proximity to lease lines, so that 25, 50, or 100-foot diameter targets are common. Lack of positive geological control and the distance from lease lines permitted Sun to designate targets with 200-foot diameters.

4. Kickoff Depth. Depths from 350 to 500 feet were chosen as the kickoff points or depths of initial deflection. Such shallow depths were chosen because:

(a) The average angle to secure the desired displacement would be reduced.

(b) It would be possible to set surface casing through that portion of the hole where angle was being increased and where the majority, if not all, the whipstocks would be set. Surface casing could readily be set below the point where the maximum angle and correct heading were reached, and as the direction and angle would remain nearly constant below surface casing, the likelihood of key-seat development or other hole trouble would be reduced.

5. Rate of Angle Build-up. While the rate of angle build-up can not be controlled precisely because of variance in local formations, common practice is to attempt a build-up of 2½ degrees per hundred feet until the maximum required angle is reached. To avoid abrupt angle changes or "dog-legs," the change in angle was limited to 5 degrees per hundred feet.

6. Casing and Hole-Size Program. Directional experience has shown that a 9⅞-inch hole is desirable if 5½-inch casing is to be set. The additional clearance afforded over an 8¾-inch hole provides greater ease and safety during the casing and drilling operations. Local conditions and the requirements of a 9⅞-inch hole dictated the program shown in Table 2.

7. Drill Pipe Protectors. Because the surface casing was to be set at an angle, abnormal wear on the drill pipe and casing was to be expected unless adequate pipe protection were provided. To minimize such wear it was stipulated that each joint of drill pipe which rotated inside the surface casing be equipped with a rubber protector, and that the diameter of the rubbers be calipered each trip. A maximum diameter of 8.25 inches and a minimum diameter of 7.0 inches were specified. The maximum was specified to assure sufficient clearance for free circulation of the drilling fluid.

8. Mud Program. Emulsion drilling fluids were considered essential for the high-angle wells, the lubricating qualities of emulsion muds having proven a marked aid to directional work. Typical mud programs are shown in Table 3.

The importance of frequent mud property tests and the necessity for close supervision were impressed on both the field supervisory personnel and the mud service company.

Drilling operation. With the exception of one short fishing operation caused by a keyseat, the directional drilling operations progressed in a satisfactory and reasonably trouble-free manner. As shown in Figures 2, 3,

TABLE 2

	Approximate Footage	Hole Size	Casing Size
Conductor.....	150 feet	20 inches	16 inches
Surface.....	3000 feet	15 inches	10¾ inches
Production....	9200 feet	9⅞ inches	5½ inches

TABLE 3

From	To	Weight	Water-Loss	Base
0	150	9 - 9.5	.....	Native
150	3000	9 - 9.5	10-20	Low pH; Emulsion
3000	6500	9.5-10.5	5-10	Lime; Emulsion
6500	TD	10.5-11	3-6	Lime; Emulsion

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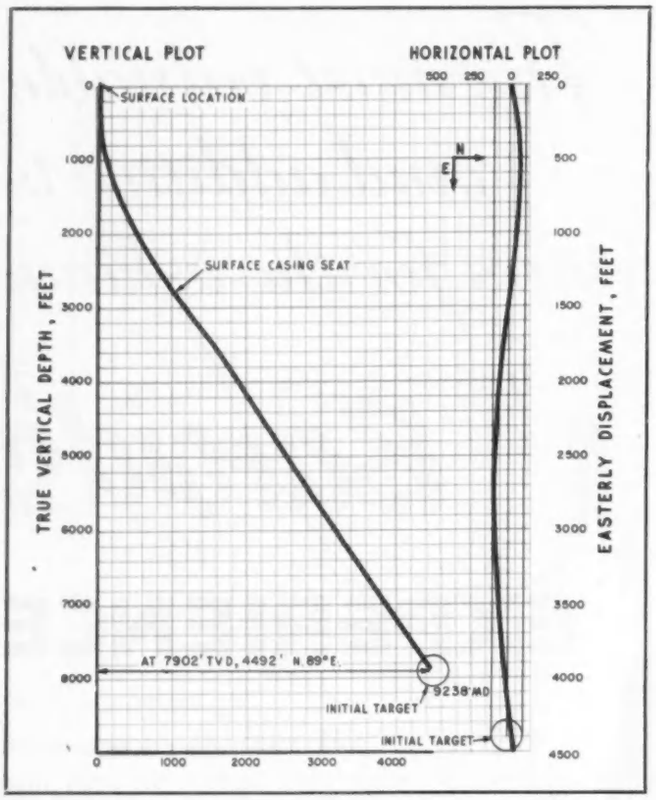

Fig. 3—Sun Oil Company, State Gulf 976-1, Kleberg County Texas.

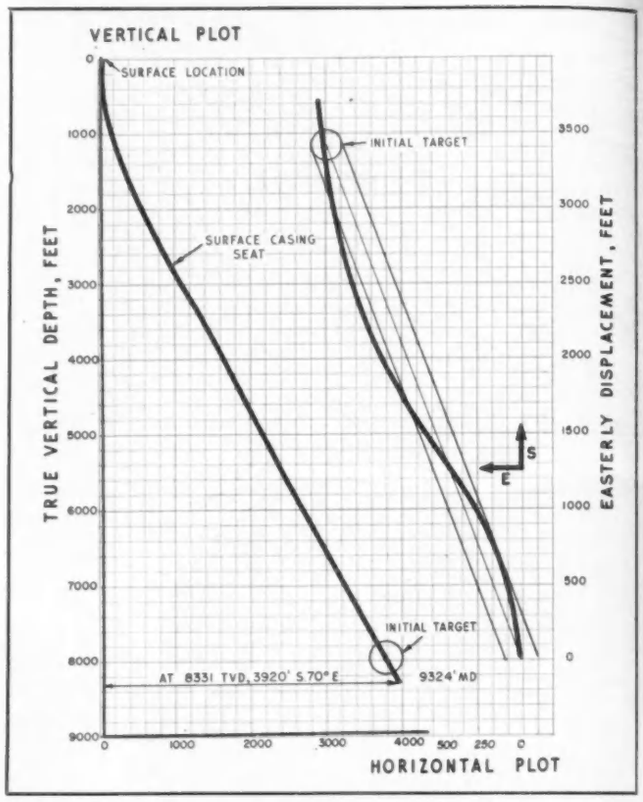

Fig. 4—Sun Oil Company, State Gulf 975-1, Kleberg County, Texas.

and 4, all holes bottomed well within the target limits, and the drilling times, listed in Table 1, are considered quite good for this specialized operation. Cost per foot of measured or drilled depth averaged about 15 percent higher than vertical wells in this area; cost per foot of vertical depth was about 30 percent higher. A reduction in cost is anticipated as more experience in the area is gained.

As a matter of interest, rig-time analyses showed that an average of 45 percent of the total rig time was spent rotating, 20 percent making trips, and 9 percent taking surveys. Approximately 20 percent of the total rig time was chargeable directly to directional operations.

Directional control and tools. Directional drilling requires the simultaneous control of the drift angle, or angle of inclination, and the direction, or angle of azimuth. Changes in angle and/or direction are commonly accomplished by one or a combination of the following:

- Whipstocks or knuckle-joints
- Varying size and position of stabilizers
- Changing weight on bit
- Changes in rotary speed
- Different types of bit
- Varying size and number of drill collars

Whipstocks, wedge-shaped steel castings with a tapered or concave channel to guide the bit, were the most effective method of controlling the direction and drift angle of the Sun wells. The number of whipstocks required on each well is shown in Table 1. Knuckle-joints were not used.

Stabilizers were run immediately above the bit, and experience indicated that a full-gage stabilizer and high bit weights were reasonably effective in increasing the drift angle. Angle was maintained or held constant with stabilizers about one-fourth inch undergage and bit weights about equal to that of the drill collars; angle was reduced by use of still smaller stabilizers. Combinations of whipstocks, stabilizers, and bit weights were used almost exclusively to control the directional holes; changes in rotary speed and different types of bits appeared to have little influence.

All surveys were taken with single-shot instrument inside K-monel drill collars. The most commonly used drilling assembly consisted of the bit, a stabilizer, two monel collars, three 7-inch drill collars, a safety joint-bumper jar, and 4½-inch drill pipe. Two monel drill collars (one of 23 feet and one of 16 feet for a total of 39 feet of monel drill collars) in tandem were used to position the single-shot instrument sufficiently far from the steel drill collars and bit to minimize the magnetic influence from the steel. This influence can be considerable in high-angle holes.

Casing operations. No difficulty was experienced during any of the casing operations. The casing strings described previously were run and cemented without incident. Conventional threaded-and-coupled casing was used with the exception of one 800-foot section of flush-joint 5½-inch which was set on bottom of the initial well. The production casing strings were somewhat heavier than those required by normal practice; no 14-pound/foot pipe was used. Both surface and production strings were equipped with centralizers, but no scratchers were used. Surface casing was reciprocated while cementing; production casing "froze" on bottom and no pipe movement was possible.

While running casing a concerted effort was made to complete the operation smoothly and rapidly. Differential fill-up equipment, power casing tongs, long uniform-length joints, and extra rig personnel helped reduce the critical time required to run casing.

Drilling difficulties. As previously mentioned, the principal difficulty ex-

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DRILLING

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November 11, 1954

Mr. H. W. Cardwell
Cardwell Manufacturing Company, Inc.
P. O. Box 2001
Wichita 1, Kansas

Dear Mr. Cardwell:

For your information and your files, we are enclosing herewith, certain compiled data relative to the operation of our two Cardwell Model "D" Rigs, in which we feel you will be interested.

As you know, our first Model "D" was delivered on January 1, 1954, and in the past ten month period this rig has drilled, with 4½" drill pipe, an accumulated footage of 71,300 feet of hole, comprised of the following:

One	7,700 foot hole
* One	7,200 foot hole
Two	6,700 foot holes
Three	5,500 foot holes
Five	5,300 foot holes

The total number of trips involved in making this amount of footage was 164 with drill pipe and 25 with tubing.

Our second Model "D" Rig was delivered to us on May 10, 1954. This rig has drilled, with 4½" drill pipe, an accumulated footage of 35,000 feet of hole, comprised of the following:

One	8,992 foot hole
* One	8,445 foot hole
One	7,850 foot hole
One	6,000 foot hole

In the drilling of these four wells, two were side-tracked and directionally drilled. The total number of trips involved in the drilling of this 35,000 feet of hole was 120 with drill pipe and 8 with tubing.

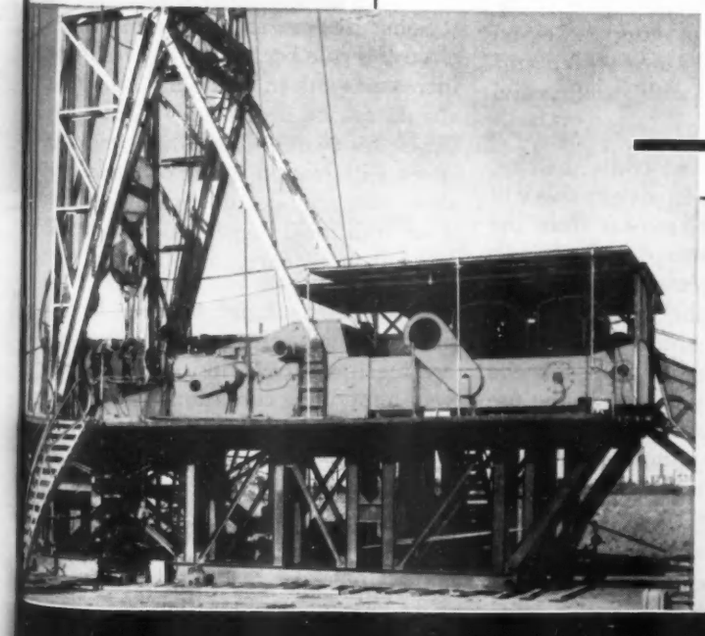
We are impressed, not only by the smooth operation of these rigs, but doubly so by the small amount of down time due to repairs, which is practically negligible. Our men class them as the best in the field in their capacity.

Yours very truly,

HOWARD PARKER COMPANY

By Howard Parker

*** MODEL D IS RECOMMENDED WITH 4½-INCH DRILL PIPE FOR DRILLING TO 5,000 FEET**



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perienced was one case of stuck pipe caused by a keyseat. Drill pipe was freed by backing off at the safety-joint above the drill collars, and the collars were recovered by washing over. Approximately two days were required to recover the stuck pipe and ream out the keyseat before drilling continued.

Other less serious difficulties included occasional bit balling in shallow shale sections, probably as a result of the high bit weights required to maintain directional control, and excessive drag, sometimes as high as 70,000 pounds, while making trips during the latter part of each well.

Supervision. Competent supervision by the directional specialist, Sun personnel, and the contractor's toolpusher was instrumental in the successful completion of this drilling program. The various operations were followed closely and the work was planned to eliminate unnecessary delay. Mistakes, breakdowns, or delays generally are more damaging on directional wells than on vertical wells, and consequently superior supervision and field planning are of relatively greater importance.

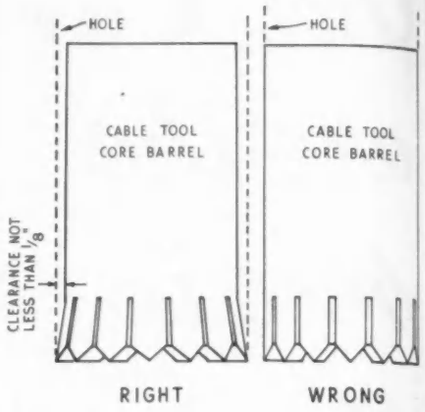
Drilling costs. Average cost of drilling these directional wells has been about $125,000 per well, including the casing investment, wellhead equipment, and surface location. It is estimated that vertical wells drilled by platform-and-tender or ocean-going drill barge would have cost a minimum of $300,000, and probably $500,000, so that the directional program was well justified economically.

Conclusion. Directional drilling has proven a valuable tool for exploring and exploiting the near-shore portions of the Texas tidelands. Techniques have been developed which result in a very favorable economical picture as compared to other methods of offshore drilling.

Sun's successful directional program may be attributed largely to:

- Careful planning; close, informed supervision; a competent and responsible directional specialist.
- Adequate drilling rig and equipment; cooperative and experienced rig personnel. —**The End**

How to Use Cable Tool Core Barrels



CLEARANCE BETWEEN outside of trimmer shoe and inside of bit should not exceed 1/32 inch.

***By* T. A. CHURCHILL,** East Side Machine Shop, Chanute, Kansas

CABLE TOOL core barrels are made and designed to be used in sand, shale or soft formations. Lime or the harder formations will frequently damage the tool, causing disappointing core recovery. The tool should be used in strict accordance with manufacturers' directions, regardless of contrary advice from drillers and others who may or may not have had much experience in core drilling. The practices set forth in the following will be of value to the core barrel owner, if they are faithfully followed:

1. Keep the tools clean, free from contaminates, rust and dirt. Foreign matter, particularly in and on the threads of the bit or barrel will quickly result in galling and permanent damage, making a good tight fit of the bit, trimmer shoe or sub impossible to make the barrel. Before fitting the bit or sub to the outer barrel, all threads should be cleaned with a stiff wire brush, washed with gasoline and lightly oiled.

2. Use a loose line while drilling. The twist and snap in a tight line will lift the outer barrel too far from the bottom, causing damage to the barrel, bit and line and retard greatly the digging action of the tool. This is of prime importance and a point which is disputed by some drillers, but the increased efficiency gained in the use of the loose line has been proved over and over from manufacturers' experience gained in repairing broken tools and manufacturers' supervision in the use of such tools. Know that the driller is using a loose line.

3. Be sure that the length and weight of both inner and outer barrels remain exactly as when received from the manufacturer. If possible, return the damaged barrel to the manufacturer or reliable machine shop for restoration to its original condition.

4. Be sure that the bit and trimmer shoe are ground and sharpened properly. Below will be found cross sections showing the right and wrong way in which these parts are used. Clearance between outside of trimmer shoe and inside of bit should not exceed 1/32-inch.

5. Have several bits and trimmer shoes on hand before starting to core. Replace bit and trimmer shoe after each run of from four to five feet. If the bit on the outer barrel is left on too long, the wearing action on the bit results in a smaller diameter.

Some drillers are reluctant to observe this rule because of the resulting increased work in changing bits, but it should not be neglected. If this practice is followed, all bits and trimmer shoes will remain approximately the same size and condition. Here are some additional suggestions which will be of value if carefully observed.

6. Tighten all joints, then break and retighten before using. When operating the barrel, rinse often to prevent a mudding condition which tends to lift the inner barrel, disturbing the trimmer shoe and damaging the core. The barrel should be run 25 to 30 strokes per minute depending on conditions. When tightening bit, sub or trimmer shoe, be sure that holding tong is set above the thread of the barrel.

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- HOMCO Safety Joints
- HOMCO Pin Type Tubing Safety Joints
- HOMCO Tubing Tool Joints
- HOMCO Substitutes

1. HOMCO Inside Cutting Tool for cutting inside drill pipe, casing and tubing.
2. HOMCO Overshot used for the recovery of pipe that has been cut "free."
3. HOMCO Outside Cutting Tool for the cutting of drill pipe that is stuck.
4. HOMCO Spear used in conjunction with the HOMCO Inside Cutting Tool requires only one run of the fishing string to cut and recover the "free" pipe.

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How to do it

DRILLING HINTS

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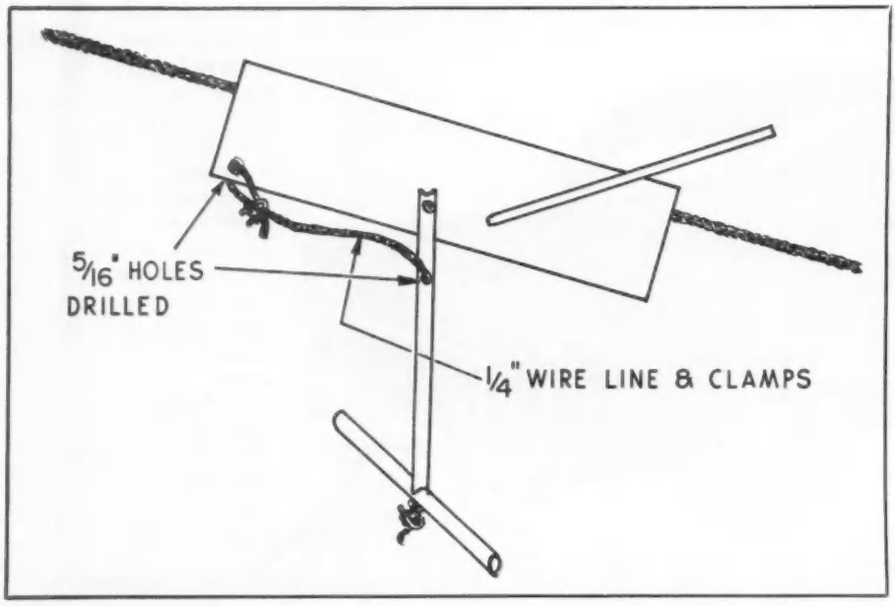


Add "T" Seat to Safety Buggy

One contractor employe working derricks devised a "T" seat that added to the safety features of the conventional safety buggy. He drilled a 5/16-inch hole in the buggy, ran a 1/4-inch steel cable through it and clamped it as shown. This idea could save the life of a derrickman who had to escape in a hurry.

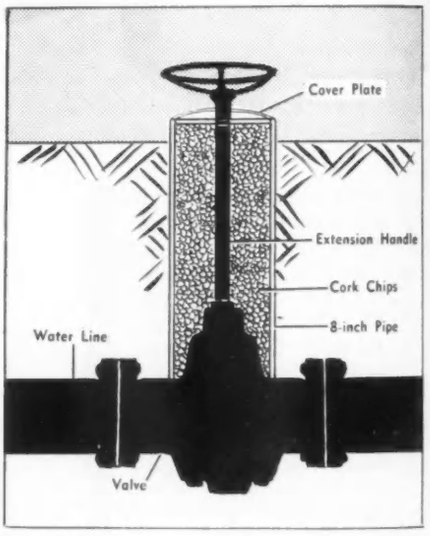
Lock Turnbuckle on Guy Line

For the many drilling contractors and operators who have radio towers, here is a simple locking device that will prevent turnbuckles holding the guys on the towers from "backing off" and loosening under strain. It will also discourage the meddler who might loosen the turnbuckles to see if the tower would fall.

The locking device is nothing more than a wire rope threaded through the turnbuckles and the eyes in the guys in figure "8" fashion. The ends are double clamped securely as shown.

Cork Chips Prevent Valve From Freezing

Fill the annular space between the extension handle and valve box with cork chips and minimize the danger of water lines freezing in sub-zero weather. The water line, shown schematically here, is below the frost line and is safe from freezing except at the valve box which is an eight-inch pipe running from the valve to the surface of the ground.



To eliminate this hazard, mount a circular cover plate, hinged for easy access, on top of the box. Fill the space below it with light cork chips. They provide sufficient insulation for the valve and are easy to remove whenever necessary.

Combination Rack-Roller Aids Drill Pipe Handling

A combination pipe rack and pipe roller (launcher) makes it easy to handle drill pipe or casing, to inspect pipe or to weld scratchers. The rack

Pick the type you like the best!

H C Smith makes both 3-CUTTER and 4-CUTTER ROCK BITS

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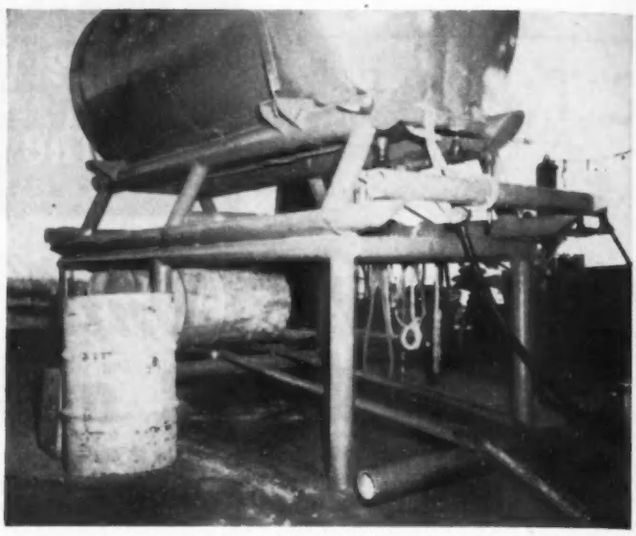
HINTS . . .

Make Fuel Supply Rack in Two Sections

has a horizontal member of four-inch pipe welded to a 2½-inch pipe that fits over the vertical leg. The four rollers are bearing mounted.

When using this unit for welding, pipe inspections or launching pipe to the derrick floor by the catline, the rollers can be used to move or position pipe.



Coppinger Drilling Company of Wichita, Kansas, constructed a support for the diesel fuel tank in a separate section so that it can be easily dismantled and moved, yet is high enough to provide gravity feed to the engines.

The bottom section, made from four-inch pipe with four-inch horizontal cross members, provides support for the drums of lubricating oil. A ramp is formed by using 2 two-inch pieces of pipe welded to a four-inch piece with the front ends of the two-inch mitred facilitating the rolling of heavy oil drums. Saddles made of six-inch pipe are welded at four points around the top to accommodate the upper skid for the fuel tank.

The fuel tank skids are also made from four-inch pipe with risers on the sides to give the tank extra elevation. Tops of the skids have brackets for the straps which hold the tank in place.

EXPERIENCE COUNTS

● Lowe Drilling Company, Inc. has acquired the 10 rotary drilling rigs formerly operated by Ralph Lowe, individually. The equipment will continue to be operated by the same well-trained and experienced personnel as in the past 10 years.

● Operating rotary drilling rigs designed to drill to 6,000 or to 15,000 feet, we will continue to serve the great Permian Basin oil industry.

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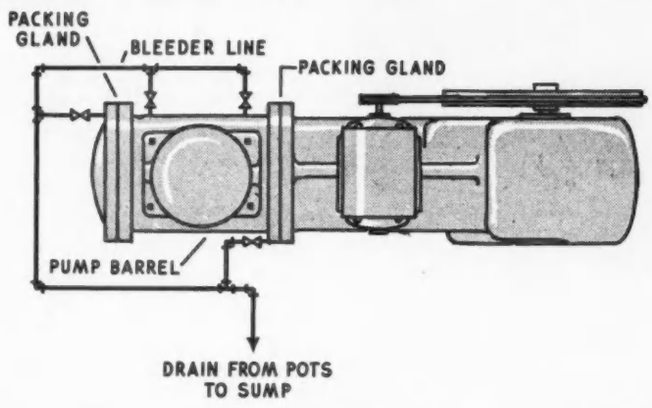
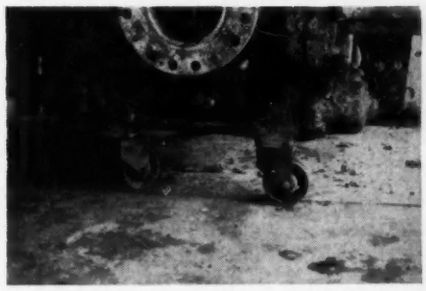


Make Drain Lines Self-Cleaning

The hookup shown here greatly improves the packing gland drain system for reciprocating pumps. It costs little and enables operators to clean the drain lines with high pressure fluid from the pump. The conventional hook-up has the drain line valves upstream from the bleeder valves, and when the line becomes clogged with oil, bugs and dirt, operators must use high pressure air to clean it.

With the bleeder valves ahead of the drain lines, the operator need only close the packing drain valves, open the bleeder valves, and the lines are clear in less than a minute. Once clear they will stay operable for weeks.

Cost of this installation is negligible, since most of the material is usually found on an existing pump. All of the valves and piping are half-inch.



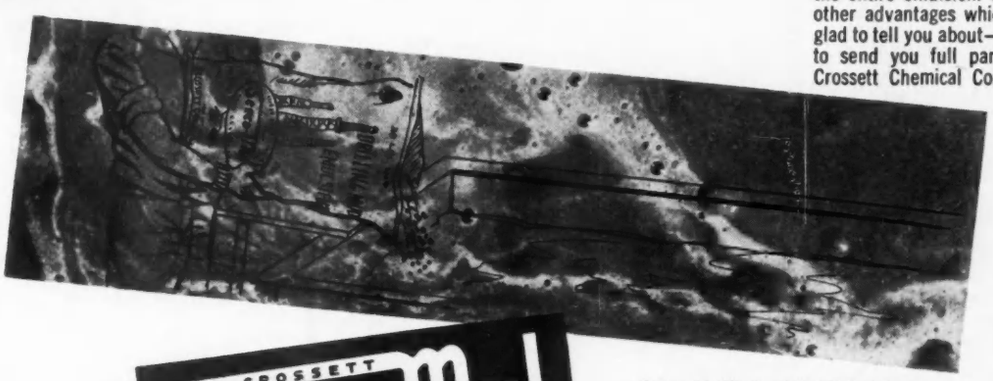
Attach Casters To Move Heavy Blowout Preventer

One major oil company has come up with a useful idea for moving heavy blowout preventer equipment on barges. Heavy duty casters (ball bearing rollers) can be screwed into the bolt recesses of the preventer as shown. The preventer can then be rolled to desired position. Preventer should be chained to substantial structural members during storms, rough water, or during moves when there is a possibility that equipment will be thrown against equipment or personnel.

The heavy wheels can also be welded directly to the bottom shell of the preventer body.

Increase Drilling Rate With Less Drill Stem Torque
Better Lubrication • Lower Pump Pressure

Seeco-Mul effectively disperses the oil in emulsion muds which affords better lubricating qualities in the mud and allows faster drilling, reduces frictional drag of the drill string, and provides a higher velocity of the fluid on bottom. With good lubricating qualities in the mud, less drill stem torque is required, pump pressures can be lowered and more evenly sustained, and the bit stays cleaner. All of this means longer service life, too, for liners, collars, tool joints, bits, and drill pipe. Seeco-Mul is completely soluble in water and readily emulsifies Diesel or crude oils for use in sodium type or limed muds; in most cases Seeco-Mul efficiently tightens the entire emulsion. Seeco-Mul has a number of other advantages which your mud dealer will be glad to tell you about—or write to us; we'll be glad to send you full particulars without obligation. Crossett Chemical Company, Crossett, Arkansas.



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Seeco-Mul
DRILLING MUD EMULSIFIER

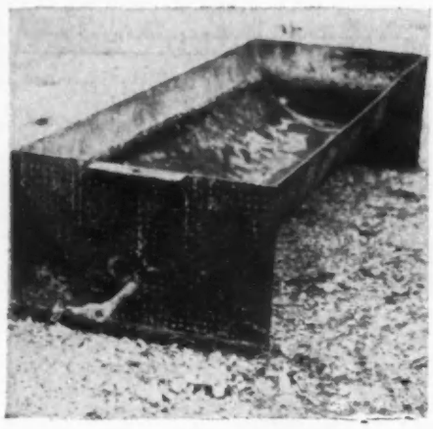
Seeco-Mul is the dried flaked form of so-called "crude floating soap," a compound of the sodium salts of abietic, linoleic, and oleic acids, together with quantities of wood tannins and lignins. Your own mud engineer can use Seeco-Mul without special instructions or equipment.

"MAKES A GOOD MUD BETTER"

HINTS . . .

Use Scrap To Make Permanent Solvent Vat

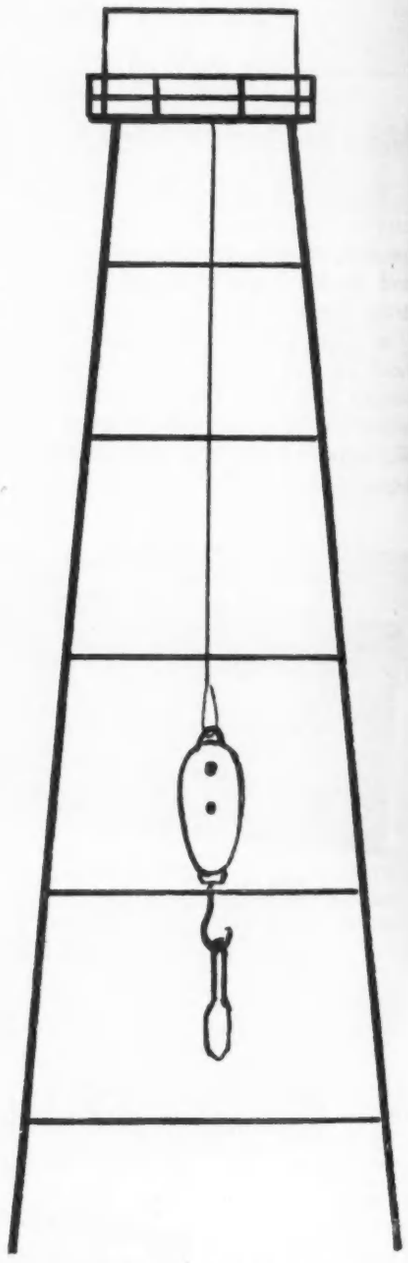
To make a permanent vat for washing heavy engine parts, radiator cores, etc., which are removed during overhaul, drilling contractors can weld together two sections of halved 30-inch OD pipe to make the tub. A 24-inch x 36-inch rectangular piece of one-fourth-inch angle iron can be tacked on for footing. A three-quarter-inch gate valve mounted on a nipple in one end of the floor plate makes the drain. The vat can then be coated



with a phenolic paint to prevent chipping and to resist the action of strong commercial solvents.

String Traveling Blocks With New, Easy Method

West Texas contractors have adopted an easy way to string up traveling blocks without placing the heavy equipment on the derrick floor. The eyelet is welded in the top side of the block and a homemade hook is suspended from a discarded length of 5/8-inch (or larger) sandline. The line hangs from a derrick girt or from a structural beam of the crown block.



By lowering the block to about eight or nine feet above the floor, the line can be brought into position and the hook fastened in the eyelet, thus suspending the block while drilling wire rope is fed in and out the pulleys or while blocks are greased or repaired.

LOCK THE DOOR *BEFORE* *THE HORSE IS STOLEN!*

KNOW when you lose mud...

with "*Pit-O-Graf*"

The Pit-O-Graf chart shows the instant lost circulation begins by recording a decrease in mud pit level. It enables action to be taken at once, while there is still time. An increase of mud in the pit, which is shown immediately on the chart, means gas or salt water. The crew has time to take action to avert a blowout. Pit-O-Graf is a completely automatic recording instrument which measures the mud pit level. With the recording unit right before the driller, he is aware at once of any increase or decrease in mud volume. Pit-O-Graf allows preventive action to be taken at once. You need Pit-O-Graf in lost circulation areas and for every wildcat.

WARREN AUTOMATIC TOOL CO. W A T C O HOUSTON

WARREN AUTOMATIC TOOL CO.

Manufacturers of Mud-O-Graf and Rig Runner.

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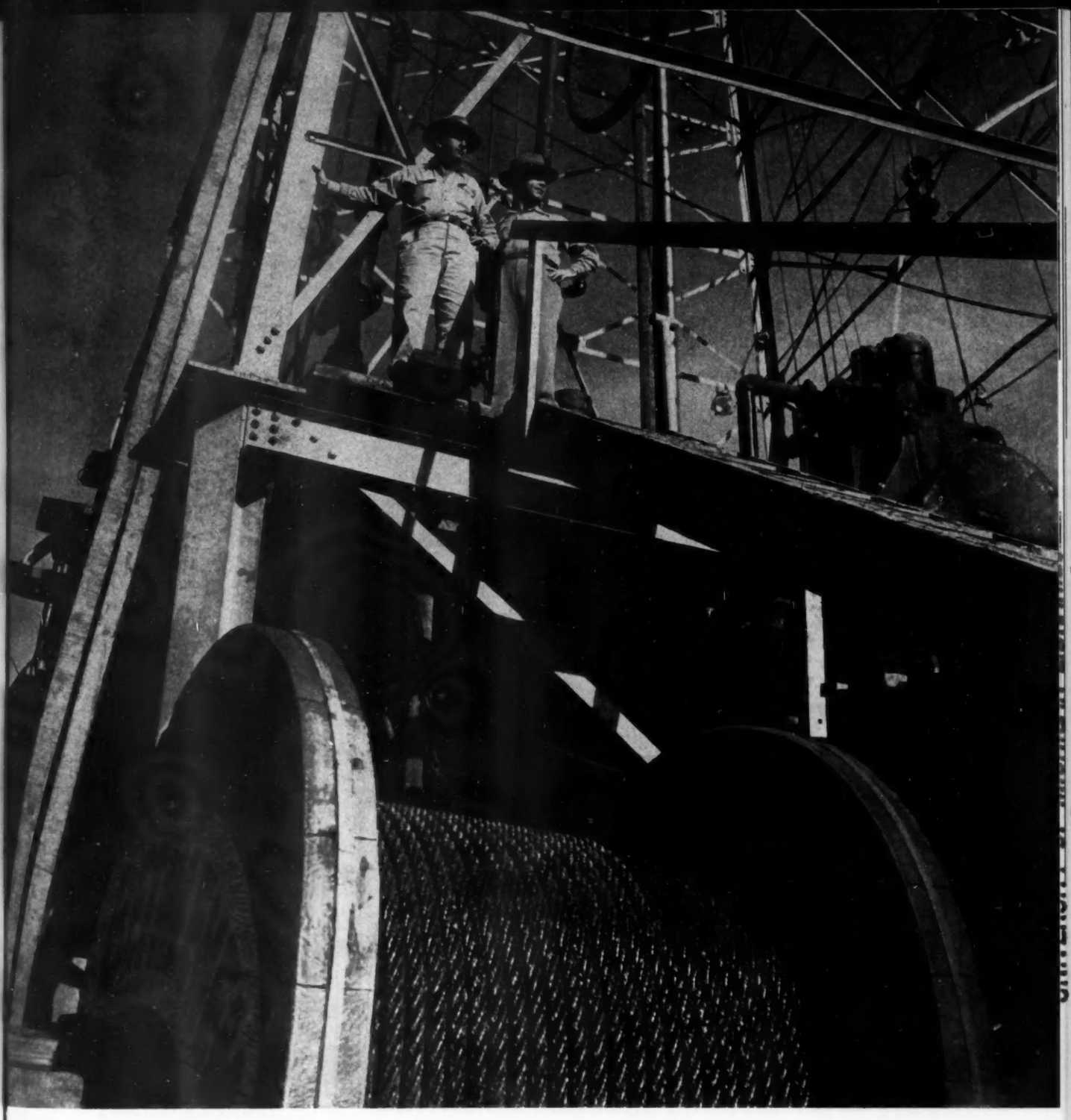
Export Representative: International Oil Equipment Co.
30 Rockefeller Plaza, New York City



Wire Rope at Work—This is Falcon Seaboard's Rig No. 12, photographed on a deep-hole job in St. Martin Parish, St. Martinville, La. When the picture was taken, drilling had pushed beyond the two-mile level.

Falcon Seaboard's No. 12 is a big outfit, capable of managing very heavy loads. So much depends upon the wire rope that unusual care is exercised in its selection and maintenance. Here the choice was 3500 ft of Bethlehem Purple Strand, 6 x 19 construction, 1¼-in. diam—Form-Set (preformed) for easy handling. Added strength and resistance to crushing were assured by an independent wire rope core. This combination provided a generous margin of reserve, and helped the rig meet every load condition very comfortably.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:
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Model PO Air-Actuated CLUTCHES

provide

REMOTE CONTROL without complicated linkage.

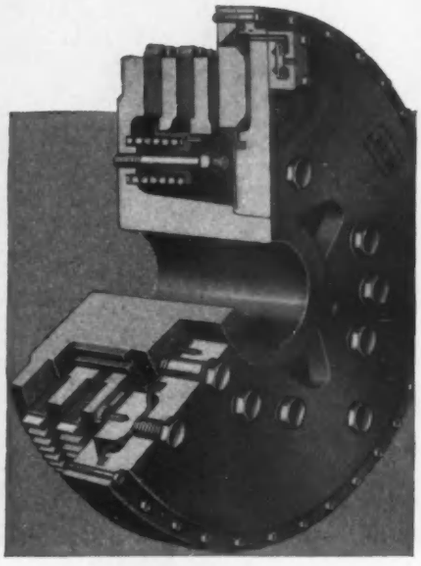
HIGHER TORQUE CAPACITY (with slippage capacities up to 120,000 lbs. ft.).

LESS WEIGHT, NARROWER WIDTH —permitting more compact installations with lower initial costs, and use of air-actuated clutches where drum or band-style clutches previously have been used.

FASTER, SMOOTHER OPERATION with positive air-sealing under all conditions; featuring fully-supported, no-stretch construction . . . extra-long stroke, and controlled flexing is provided by the exclusive Twin Disc diaphragm.

POSITIVE, QUICK RELEASE . . . no seal-drag . . . built in pressure release valves.

INVESTIGATE Twin Disc Model PO Air-Actuated Clutches for designing into new equipment, or for modernizing older models . . . *write today for new Bulletin 304!*

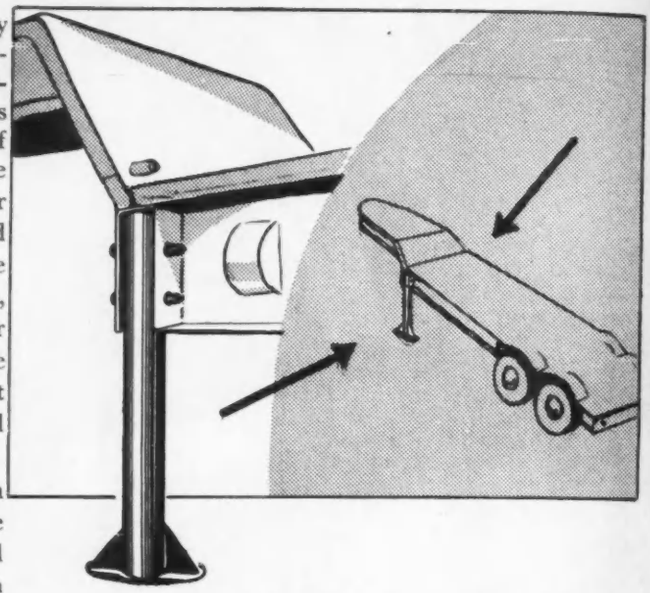


TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

Add Extra Legs to Lowbed Trailer



When necessary to hitch and unhitch from a "lowboy" several times a week, a set of legs attached to the front of the trailer will keep the bed level and make loading easier. Also, the truck tractor can back under the fifth-wheel without lifting the front end off the ground.

The legs, which are detachable, are carried on the bed of the trailer when on the road.

Wells for the legs can be made by cutting out the lower lip of the channel iron beam along the side of the trailer and welding a plate along the back to match the existing plate at the end of the channel iron.

The legs, made from four-inch pipe with plates welded over the lower ends to keep them from sinking into the ground, are set in the wells at the front of the trailer bed. Pins fitted into two holes, burned through the frame and pipe with a welding torch, keep them steady. When it is time to unhitch the trailer, it is simple to loosen the winch line, disconnect the pin on the front and move off.

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in Power Plant Maintenance

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Pure Colloidal Concentrate
Ounces Only Once A Week
Safely Remove and Prevent
Boiler Scale and Corrosion

SAVES MONEY
INCREASES EFFICIENCY
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Its powerful yet gentle colloidal action removes and prevents scale and corrosion despite water and operating conditions. Harmless to personnel and equipment.

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SABANOL
THE HOMOGENIZING FUEL OIL TREATMENT

for
Clean and Complete Combustion of ALL Grades of Fuel Oils.

Contains an EXCLUSIVE Soot Retardant and Rust Inhibitor.

NON-TOXIC
NON-CORROSIVE
NON-EXPLOSIVE

ABSOLUTELY SAFE to use and to store.

Flash Point over 200° F.

RUSTEND—Provides protection against rust on all metals and equipment subject to prolonged outdoor exposure.

SEND FOR
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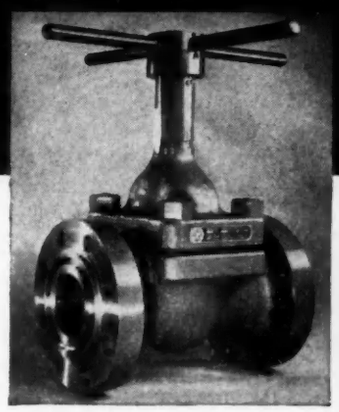

"The best mudline valve we've ever used is that new Rockwell-built MUDWONDER"

Here are some of the discoveries MUDWONDER users are making —quick, easy disassembly and re-assembly . . . easier, faster valve operation . . . no sanding-up . . . longer service life . . . less down-time . . . reduced maintenance . . . drop-tight shut-off . . . piping hook-ups stay together during inspection or part replacement—in other words, ECONOMY and RUGGED DEPENDABILITY.

Interchangeability of operating parts, a regular feature of all Edward valves, adds to MUDWONDER economy. The self-aligning gate of hard-chromed alloy steel and the one-piece seat insert of buna-N molded integrally to steel wear rings are the same in the 3000 psi WP (6000 psi test) and the 2000 psi WP (4000 psi test) MUDWONDER valves.

Replace troublesome mudline valves by ordering new MUDWONDER valves today.

Your favorite supply store has stock or can quickly fill your requirements from the Edward warehouses in Houston—1515 Fulton Street, phone CHarter 0863—or in East Chicago—1214 West 145th Street, phone East Chicago 231.

Edward Valves, Inc.
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Send me your latest MUDWONDER catalog and price list for 3000 psi WP (6000 psi test) and 2000 psi WP (4000 psi test) mudline valves.

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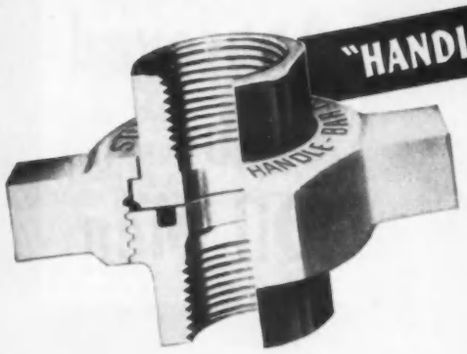
Unions



are drop forged from highest quality forging bars. Accurately machined and finished to precision dimensions. Rigidly inspected throughout production and air tested under oil after completion to meet the highest standards of quality.

PERMANENTLY LUBRICATED NUT THREADS for quick and easy make and break. EXTRA HEAVY HANDLE BAR NUTS to withstand rugged use. "O" RINGS FORM PERFECT SEAL to retain pressures. "O" RINGS will not fall out. SEPARATE "O" RINGS are available for services and temperatures up to 500°F.

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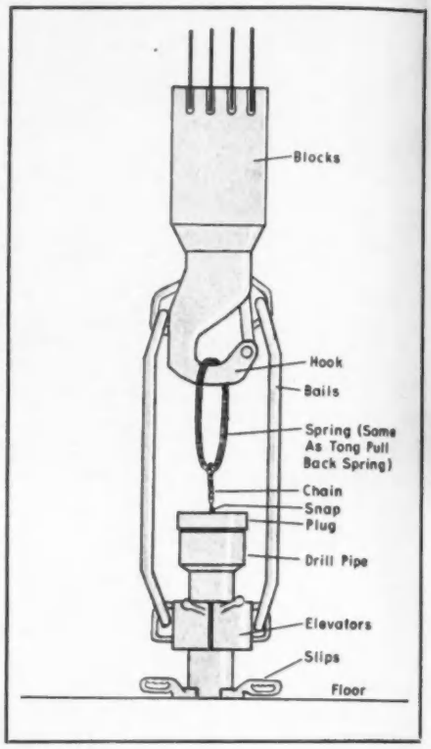
HINTS . . .



Pull-Back Spring Permits Quick Removal of Plug

One company has devised a simple drill pipe plug with a tension spring that permits rapid removal of plugs and fast connections during gassy or oily tests.

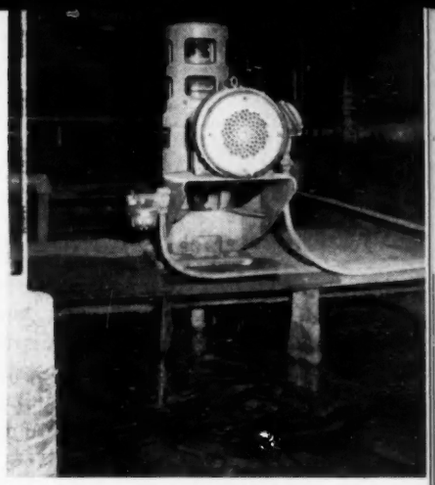
Its principle is simple but effective. A pull back spring is looped around the hook as shown. A chain welded to a snap fastener on top of the plug completes the device.

Usually the stand of pipe had to be lowered into the mouse hole and the derrickman had to remove the plug by hand. This operation required two or three movements, and the necessary signaling from the derrickman made the practice hazardous.

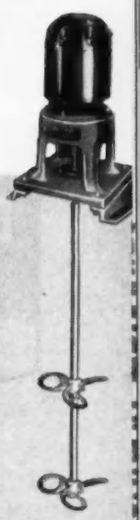
Now, with the spring, crewmen do not have to touch the plug after it has been screwed in, and the stand does not have to be lowered into the mouse hole and picked up again before being racked.

As a stand is pulled, it is set back on top of a plug that has been inserted into the next stand. The spring tension holds the pipe while the driller screws the pipe out of the plug.

MUD stays in excellent condition, ready for instant use—every gallon the same weight and viscosity. LIGHTNIN Mud Mixer holds it uniform and prevents settling.



YOU CAN SEE why LIGHTNIN-mixed mud is always in condition. In this LST barge off Galveston Bay, all the mud flows and interchanges constantly. Weight additions to mud show up at once throughout the system.



FAST CONTROL of weight and viscosity is obtained by dumping in weight and gel additions, as rapidly as desired, through a LIGHTNIN Flash Mixer.

Get uniform mud . . . **in seconds** *and* **keep** *it that way*

This new mud mixing method can give you:

1. Instant dispersion of weight and gel additions
2. Constant uniformity in the mud system
3. Savings up to $450 per month

Now you can keep mud just the way you want it. You can *change* mud condition *in a few seconds.*

And you can cut operating cost to boot. Many drilling superintendents and tool pushers are doing it already.

With this newest method of mixing mud, you dispense entirely with mud guns and slow-feeding hoppers. You eliminate *waiting* for mud to heavy up—so you drill more hole per shift.

You end losses caused by mud settling out of circulation. Thus you have the full capacity of the mud tank or pit ready for instant use, always.

And you get extra safety against blow-outs—*immediate* weight rise when you need it, all through the mud system.

Heavier mud—in seconds

Here's how you get this rapid control of mud in your tanks or pits:

1. You *flash-mix* weight and gel additions into the incoming mud stream. Flash-mixing is done with a LIGHTNIN Flash Mixer, equipped with special propellers to break lumps and give *instant* dispersion of weight and gel in the incoming mud.
2. You *circulate* mud throughout the tank or pit with one or two LIGHTNIN Mud Mixers (depending on pit size). A big rotating impeller creates powerful mud flow throughout the entire fluid mass—"takes hold" of the mud and turns it over and over rapidly for thorough, uniform mixing. Mud is always in the condition you want; always ready.

You can add weight material sackful after sackful—as fast as you want to dump it in. You get an *immediate* rise in weight, throughout the whole mud system. A few seconds is all it takes to increase weight of every gallon of mud by the exact amount you want.

You get immediate dispersion of gel ingredients—and you get fully uniform viscosity in minutes.

Cut pump maintenance

You can actually *reduce* operating costs with LIGHTNIN Mixers. You eliminate the cost of abrasive wear-and-tear on guns, valves, pipe, and fittings.

You save mud pump capacity, too. None of your pumps are used for mixing. You eliminate much wear-and-tear on the stand-by pump. On deep holes, you save the entire cost of a third mud pump, and as much as 90% of the cost of replacement parts for it ($180 to $450 per month).

You use less power for mixing; only 10 to 25 HP. And you can use electric, steam or gasoline power to drive LIGHTNIN Mud Mixers.

No risk; here's why

You take *no* risk when you choose LIGHTNIN Mixers for your drilling mud. Every LIGHTNIN is unconditionally guaranteed to do the mixing job for which it is recommended. This guarantee is backed up by scores of successful LIGHTNIN installations in the drilling industry.

But don't take our word for it—*see for yourself* what LIGHTNINs are doing on rigs near you. Your nearest LIGHTNIN sales engineer will gladly arrange a demonstration for you—without obligation, of course.

For details, write or wire us today.

Lightnin® Mixers

MIXCO fluid mixing specialists

FREE—6-minute "picture story" folder shows how and why you get better mud, and save money too, with LIGHTNIN Mixers. No obligation. Send for a copy today.

MIXING EQUIPMENT Co., Inc.,
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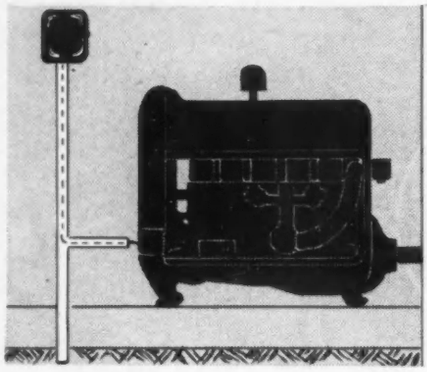
Stand for Field Clock Made from Scrap Pipe

A stand for the field time clock placed on pumps for water wells or on electric generator equipment around the rig can be easily made of one-inch pipe. The pipe, shaped as shown, is driven into the ground; the wire, threaded through and tied into the clock.

This conduit arrangement reduces the hazard of breaking the wires that run from the ignition switch.

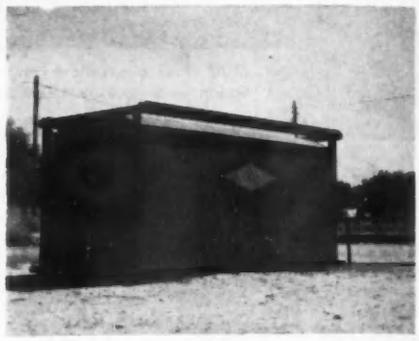


Set Extra Equipment On Top of Doghouse

One New Mexico drilling contractor has welded a structural steel brace across the top of the tool house so that other equipment can be placed above the structure shown.

If an elevated fuel, water tank or junk box is desired, a winch line from a ginpole truck can lift the building or tank on top of the doghouse with most of the additional weight being supported by the main beams shown.

A steel ladder at the left of the door provides access to the top.



Important Data on EXPLOSION RESISTANT SNUBBERS by BURGESS-MANNING

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Introducing A NEW SERIES OF 3 EXPLOSION RESISTANT SNUBBERS
ENGINEERED TO YOUR SPECIFICATIONS

Here is the answer to your surge and noise problems created by engines, compressors and vacuum systems. Burgess-Manning "BE" Snubbers are engineered to your specific need — designed to reduce that annoying exhaust roar to a smooth, quiet, and harmless discharge —and ruggedly built and internally reinforced to resist explosive pressures.

Profit through better neighbor and employee relations—avoid compensation claims.

Write for complete information giving full specifications of your requirement

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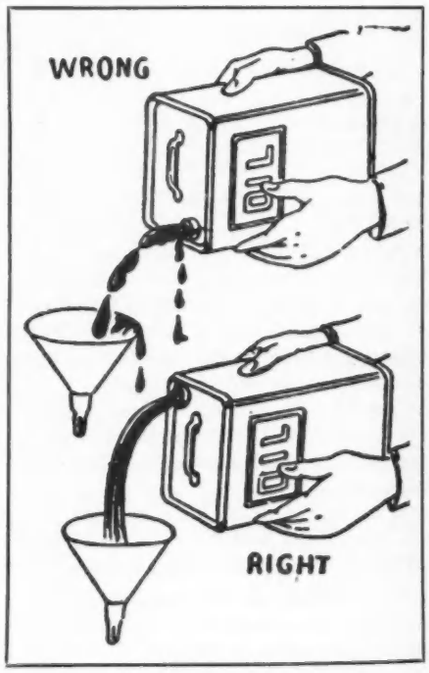

Proper Pouring Methods Can Prevent Accidents

The correct way to pour oil or other viscous material is shown by the diagram. Many times injuries are caused because of careless pouring which could have been prevented if spillage had been wiped up with a cloth or if proper pouring technique had been used.

How Well Completion Damage Can Be Determined Graphically

Basic data for this new technique are obtained from an analysis of bottom-hole pressure buildup curves.

By **J. J. ARPS,** Vice President, The British-American Oil Producing Company, Dallas

EFFECTIVENESS OF a well completion can be determined rapidly by a new graphic method. It is based on an analysis of bottom-hole pressure buildup curves, which in the past few years have developed into a powerful tool in the field of reservoir and production engineering. If the basic data are assembled with care, the interpretation often may yield information heretofore almost impossible to obtain regarding the well and the reservoir from which it produces.

This effectiveness of a well completion will be expressed as completion factor (CF), which is "the percentage of the theoretically possible productivity which actually has been obtained." For instance, if the completion factor of a well is 100 percent, it means that its productivity index is equal to that of a perfectly clean completion in open hole in the formation under consideration. If the completion factor is found to be less, say 50 percent, it means that 50 percent of the productivity is destroyed in the process of completion by mud contamination, cement or otherwise. If the completion factor of a well is found to be higher, say 150 percent, it means that the productivity has been improved over that of a clean open hole completion by means of some fracturing process, acidizing, shooting or otherwise.

This completion factor can be determined directly from the well under observation because the bottom-hole pressure buildup curve not only yields the flow characteristics of the formation $\frac{kh}{\mu}$ beyond the damaged or stimuated area, from which the theoretical productivity index can be calculated, but also its actual productivity index because the flowing pressure, the static pressure and the producing rate are known.

van Everdingen and Hurst, who first recognized the skin effect phenomenon and presented the industry with their outstanding mathematical analysis[4, 5] of its fundamentals, show how the skin effect or completion damage can be computed from bottom-hole pressure buildup data. This skin (S) is defined by these authors as "the pressure drop per unit rate of flow caused by the skin." G. B. Thomas[3] determines a damage factor (DF) from buildup data and defines this function as: "the fraction of drawdown required to overcome damage."

Simplified yardstick. In practical application of these methods it became evident that a somewhat easier-to-understand yardstick would be helpful and that more widespread use of this very valuable tool would be encouraged if a simpler, preferably graphical, method could be developed to determine its value. The completion factor as proposed here fulfills the requirement of simplicity. Its relation to the van Everdingen-Hurst skin (S) or skin effect (qS) may be expressed as:

$$CF = 100\left(1 - \frac{qS}{p_s - p_f}\right)\% \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

and to Thomas' damage factor (DF) as:

$$CF = 100(1 - DF)\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The graphical method to determine this completion factor consists of the following steps:

1. Produce the well at a steady rate for about ten days prior to shut-in, and determine the pseudo-producing time (t_{min}) from cumulative production (N_p) and the average oil production rate ($q_{(b/d)}$) by means of:

$$t_{min} = 1440\, N_p \div q_{(b/d)} \text{ minutes} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

2. Run the bottom-hole pressure bomb while the well is producing. Shut the well in and measure the bottom-hole pressure at various times ($\triangle t$) from the time of shut-in, which form a geometrical series such as: 0 minutes ($p_f = p_t$), 15 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, etc. This procedure will later improve the accuracy of plotting on semilog paper, since the points will be spaced at equal intervals.

3. Plot the observed bottom-hole pressure as ordinates

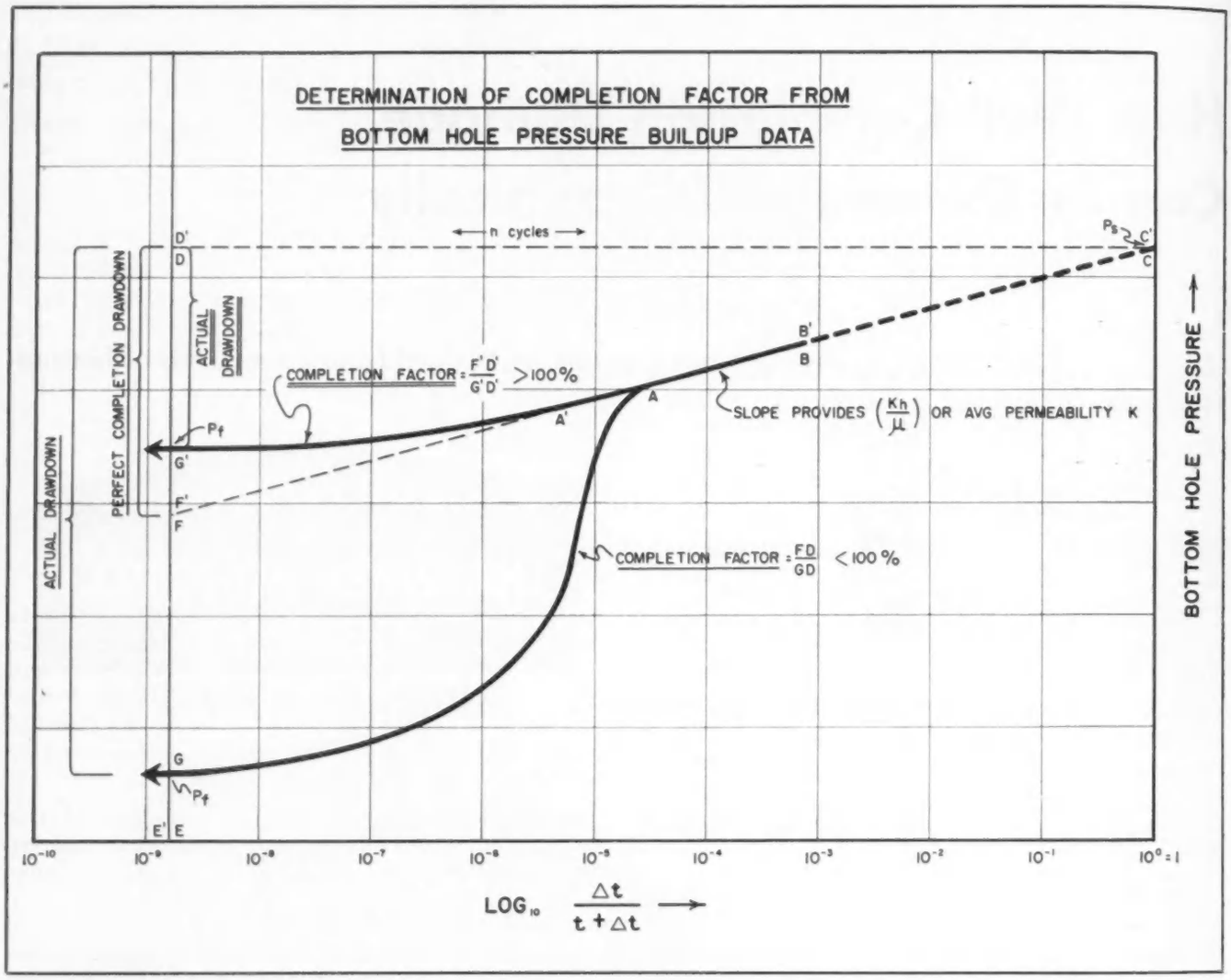

Fig. 1—Construction of a curve like this one may be used to determine the completion factor. It is based on data obtained from were obtained from bottom-hole pressure buildup curves on two producing wells.

against the ratio $\frac{\Delta t}{t+\Delta t}$ on a horizontal logarithmic scale, as shown on Fig. 1.

4. Extrapolate the straight line portion (AB) of the resulting graph to a value for $\frac{\Delta t}{t+\Delta t}$ equals 1 to find the static bottom-hole pressure (p_s) at point C.

5. Draw a horizontal line (CD) to the left from the value p_s over a distance of n cycles (see under "A" below) and draw a vertical line (DE) downward to the horizontal axis.

6. Find the intersection (F) of line DE with the leftward extension of the straight line AB of the bottom hole pressure buildup curve and also the intersection (G) (flowing bottom hole pressure, p_f) with the pressure buildup curve.

7. The completion factor can then be found by multiplying the ratio FD/GD with 100 percent.

Determination of the number of cycles (n) is as follows:

A. For depletion type or solution gas drive type reservoirs of limited extent, or for other cases where the porosity (f), or the compressibility of the fluids in the pore space (c) is not well enough known, the following values for n may be used:

Spacing (acres/well)	Values for n Well Bore Radius r_w $3'' = ¼'$	$4.5'' = ⅜'$
10	n = 5.91	n = 5.56
20	n = 6.22	n = 5.86
40	n = 6.52	n = 6.16
80	n = 6.82	n = 6.46

It will be noted that neither the well spacing nor the well bore radius (r_w) is particularly critical, and that in most cases an average value for n of about 6.2 is probably good enough.

B. For under-saturated reservoirs of large extent where the necessary factors are known from bottom-hole sample, log or core data a better value for n can be computed from the following formula:

$$n = \log \frac{.001421 \times k_{mD} \times t_{min}}{f \times \mu \times c_{psi} \times r^2_{w(in)}} \text{ cycles} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

in which the permeability (k_{mD}) is expressed in millidarcies, the pseudo-producing time (t_{min}) in minutes, the porosity (f) as a fraction, the oil viscosity (μ) in centipoises, the compressibility (c_{psi}) of the formation fluid

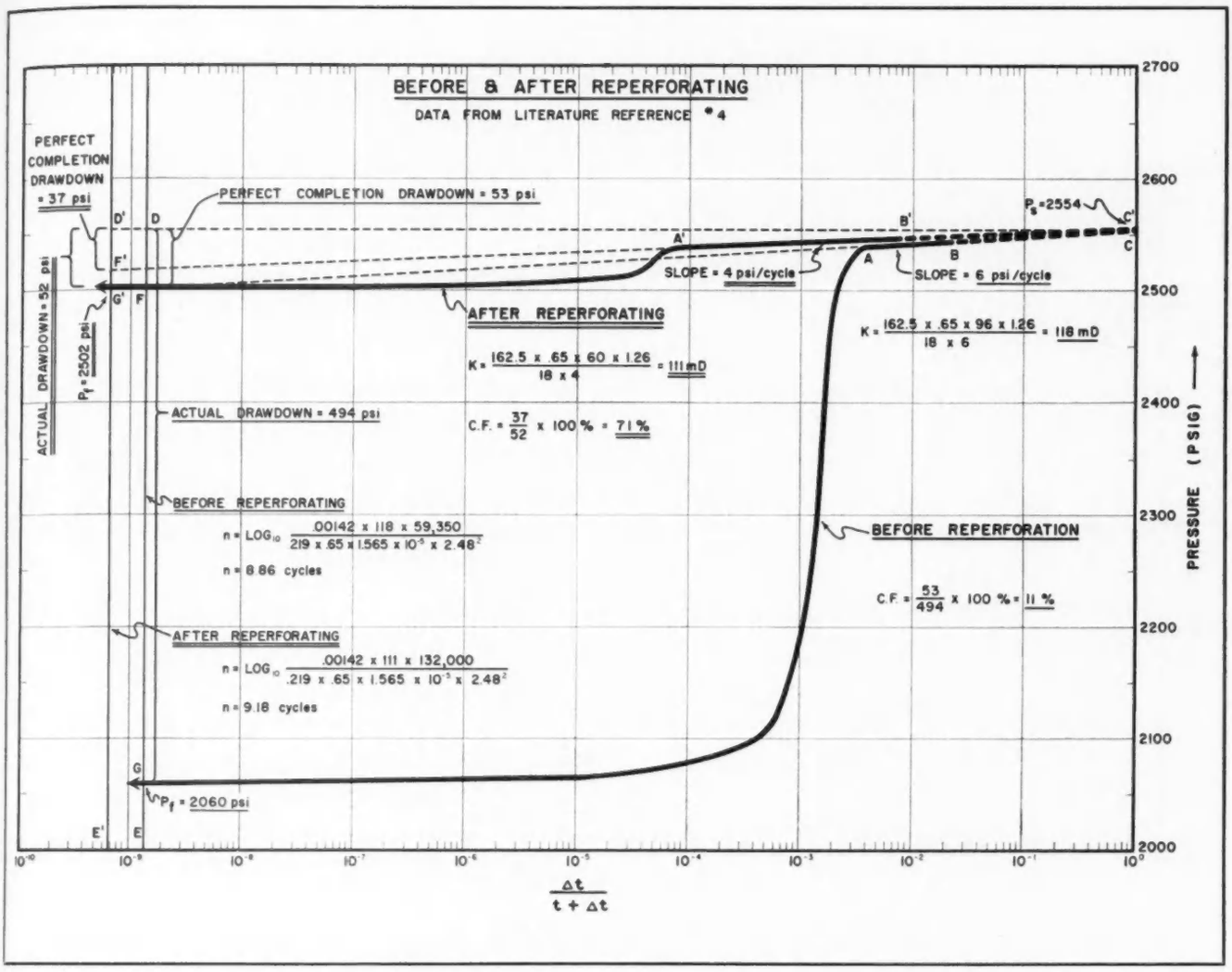
BEFORE & AFTER REPERFORATING
DATA FROM LITERATURE REFERENCE #4
PERFECT COMPLETION DRAWDOWN = 37 psi
PERFECT COMPLETION DRAWDOWN = 53 psi
ACTUAL DRAWDOWN = 52 psi
P_i = 2502 psi
P_s = 2554
SLOPE = 4 psi/cycle
SLOPE = 6 psi/cycle
AFTER REPERFORATING
$K = \frac{162.5 \times .65 \times 60 \times 1.26}{18 \times 4} = 111$ mD
C.F. = $\frac{37}{52} \times 100\% = 71\%$
ACTUAL DRAWDOWN = 494 psi
BEFORE REPERFORATING
$n = \text{LOG}_{10} \frac{.00142 \times 118 \times 59,350}{.219 \times .65 \times 1.565 \times 10^{-5} \times 2.48^2}$
n = 8.86 cycles
AFTER REPERFORATING
$n = \text{LOG}_{10} \frac{.00142 \times 111 \times 132,000}{.219 \times .65 \times 1.565 \times 10^{-5} \times 2.48^2}$
n = 9.18 cycles
$K = \frac{162.5 \times .65 \times 96 \times 1.26}{18 \times 6} = 118$ mD
BEFORE REPERFORATION
C.F. = $\frac{53}{494} \times 100\% = 11\%$
P_f = 2060 psi
PRESSURE (PSIG)
$\frac{\Delta t}{t + \Delta t}$

Fig. 2—Beneficial effect of a reperforation job is evaluated in the above curve. Data are adopted from the example in van Everdingen paper listed in references.

in vol./vol./psi, and the borehole radius ($r_{w(in)}$) in inches.

The ratio $\left(\frac{k_{md}}{\mu}\right)$ can also be determined directly from the slope (Z_{psi}) of the straight line portion of the buildup curve, if the average past production rate ($q_{(b/d)}$), the formation volume factor (B), and the net pay thickness (h_{ft}) are known, by means of

$$\frac{k_{md}}{\mu} = \frac{162.5 \times q_{(b/d)} \times B}{h_{ft} \times Z_{psi}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Examples. On the example of Fig. 2 is shown how the beneficial effect of a reperforation job is evaluated. Data are adopted from the example in van Everdingen's paper.[4]

Before reperforating, the slope of 6 pounds per square inch per cycle was extended over 8.86 cycles to show a theoretical drawdown of 53 psi. Since the actual drawdown was 494 psi, the completion factor was calculated as 11 percent. After reperforating, the deep bag at the beginning of the buildup curve (which is usually an indication of considerable completion damage) disappeared. The slope of 4 psi per cycle was extended this time over 9.18 cycles to show a theoretical drawdown of 37 psi. Compared to an actual drawdown of 52 psi, this indi-

About the Author

JOHN J. ARPS, formerly manager of production research and economics, was recently appointed vice-president in charge of the Economics and Evaluation Department of The British-American Oil Producing Company, Dallas. A native of The Netherlands, he was graduated from the Technical University of Delft, Holland, in 1932. He worked in eastern Europe, the Far East, South America and then in the U.S. with Shell before joining British-American in 1940 as district engineer for their Gulf Coast area. Later, he became chief engineer and assistant general superintendent and in 1949, was made manager of production research and economics.

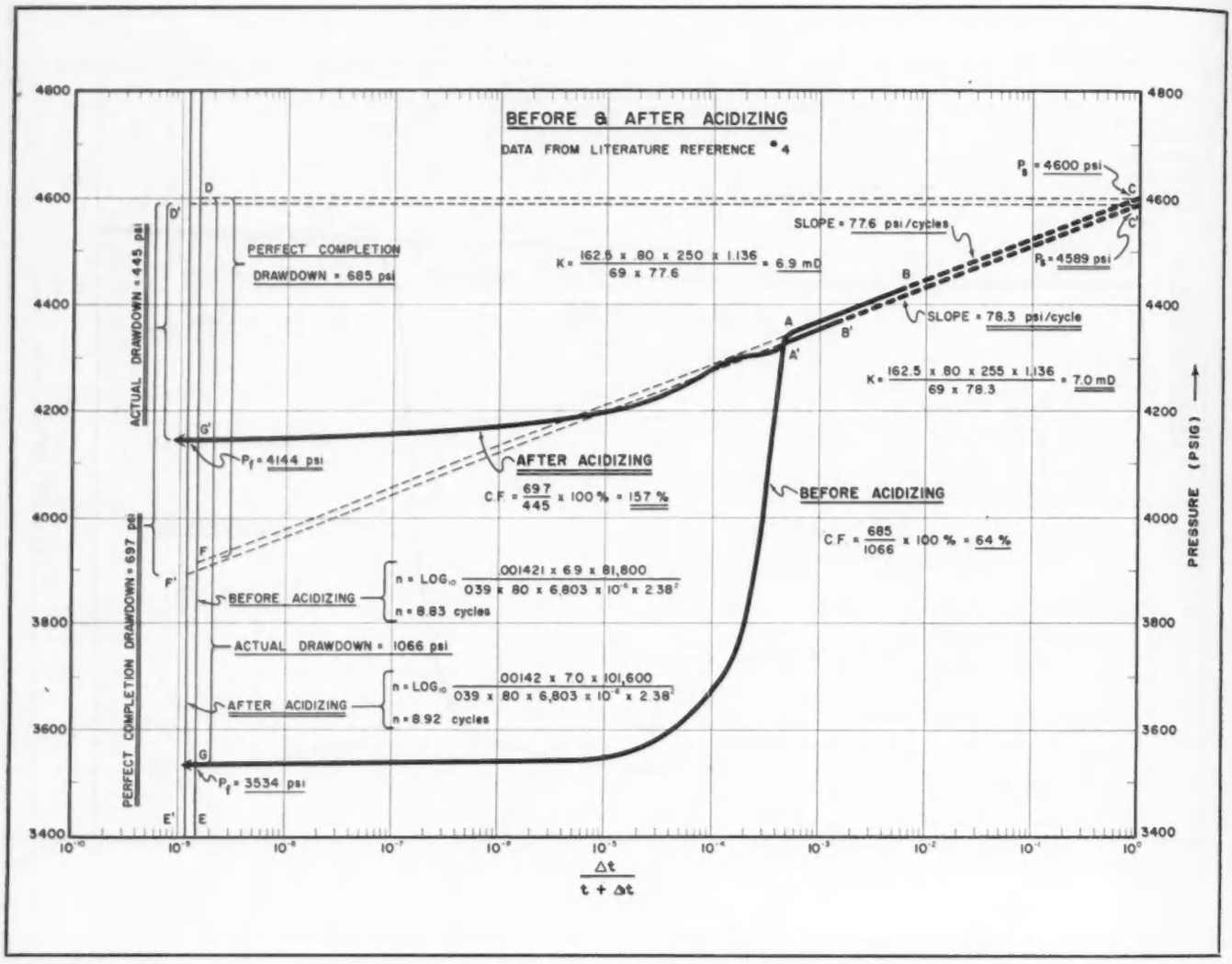
BEFORE & AFTER ACIDIZING
DATA FROM LITERATURE REFERENCE *4
P_s = 4600 psi
SLOPE = 77.6 psi/cycles
P_s = 4589 psi
PERFECT COMPLETION
DRAWDOWN = 685 psi
K = 162.5 x 80 x 250 x 1.136 / 69 x 77.6 = 6.9 mD
SLOPE = 78.3 psi/cycle
K = 162.5 x 80 x 255 x 1.136 / 69 x 78.3 = 7.0 mD
ACTUAL DRAWDOWN = 445 psi
P_f = 4144 psi
AFTER ACIDIZING
C.F. = 697/445 x 100 % = 157 %
BEFORE ACIDIZING
C.F. = 685/1066 x 100 % = 64 %
PERFECT COMPLETION DRAWDOWN = 697 psi
BEFORE ACIDIZING
n = LOG10 .001421 x 6.9 x 81,800 / .039 x 80 x 6,803 x 10⁻⁶ x 2.38²
n = 8.83 cycles
ACTUAL DRAWDOWN = 1066 psi
AFTER ACIDIZING
n = LOG10 .00142 x 7.0 x 101,600 / .039 x 80 x 6,803 x 10⁻⁶ x 2.38²
n = 8.92 cycles
P_f = 3534 psi
PRESSURE (PSIG)
Δt / t + Δt

Fig. 3—Benefits from an acidizing treatment are evaluated in this set of curves based on bottom-hole pressure buildup curves. Data were adopted from van Everdingen's paper listed in references.

cated a new completion factor of 71 percent, or a 6.5 times more effective completion than before.

On the example of Fig. 3, which is also adopted from van Everdingen's paper,[4] is shown the evaluation of the benefits of an acidizing job.

Before acidizing, the slope of 77.6 psi per cycle was extended over 8.83 cycles to show a theoretical drawdown of 685 psi. Since the actual drawdown was 1066 psi, the completion factor was calculated as 64 percent. Acidizing eliminated the initial deep bag in the buildup curve, as did reperforating in the previous example. The slope of 78.3 psi per cycle was extended 8.91 cycles to show a theoretical drawdown of 697 psi. The actual drawdown, however, was 445 psi, which indicated a completion factor of 157 percent, or a 2.5 times better completion than before the acid job.

The example of Figure 4 illustrates the effect of a hydraulic fracturing job on productivity. The two wells from which this example was taken are producers from the Lake Sand in the Bankline-Owen Pool, Eastland County, Texas.

The top buildup curve was taken on a well with 11 feet of 40 millidarcy pay which was completed through casing perforations, without hydraulic fracturing, while the bottom buildup curve was taken in the offset well with 18 feet of 1.6 mD pay after a fracturing job was performed through the casing perforations. It may be noted that the considerable completion damage in the first case is immediately evident from the deep bag at the beginning of the buildup curve, while the beneficial effect of the fracturing job is apparent from the fact that the initial part of the bottom curve A′G′ is well above straight line C′F′.

In the non-fractured well, the slope of 21 psi per cycle was extended 6.16 cycles (depletion type reservoir, 40-acre spacing, 9-inch borehole) to find the theoretical drawdown of 130 psi. Since the actual drawdown was 443 psi, the completion factor was calculated as 29 percent. In the fractured well of Fig. 4, the slope of 177 psi was extended over 6.16 cycles to find the theoretical drawdown of 1092 psi. Since the actual drawdown was 700 psi, the completion factor is computed at 156 percent.

Derivation of Completion Factor Equations

A. Depletion or solution gas drive reservoirs. For depletion type reservoirs of radius r_e, drained by a well located in the center, and where the fluid compressibility per unit pressure drop is small and constant, and where no fluid moves across the external boundary, van Everdingen's steady state case of compressible fluid flow holds. For those conditions (reference 4, equation 2) the follow-

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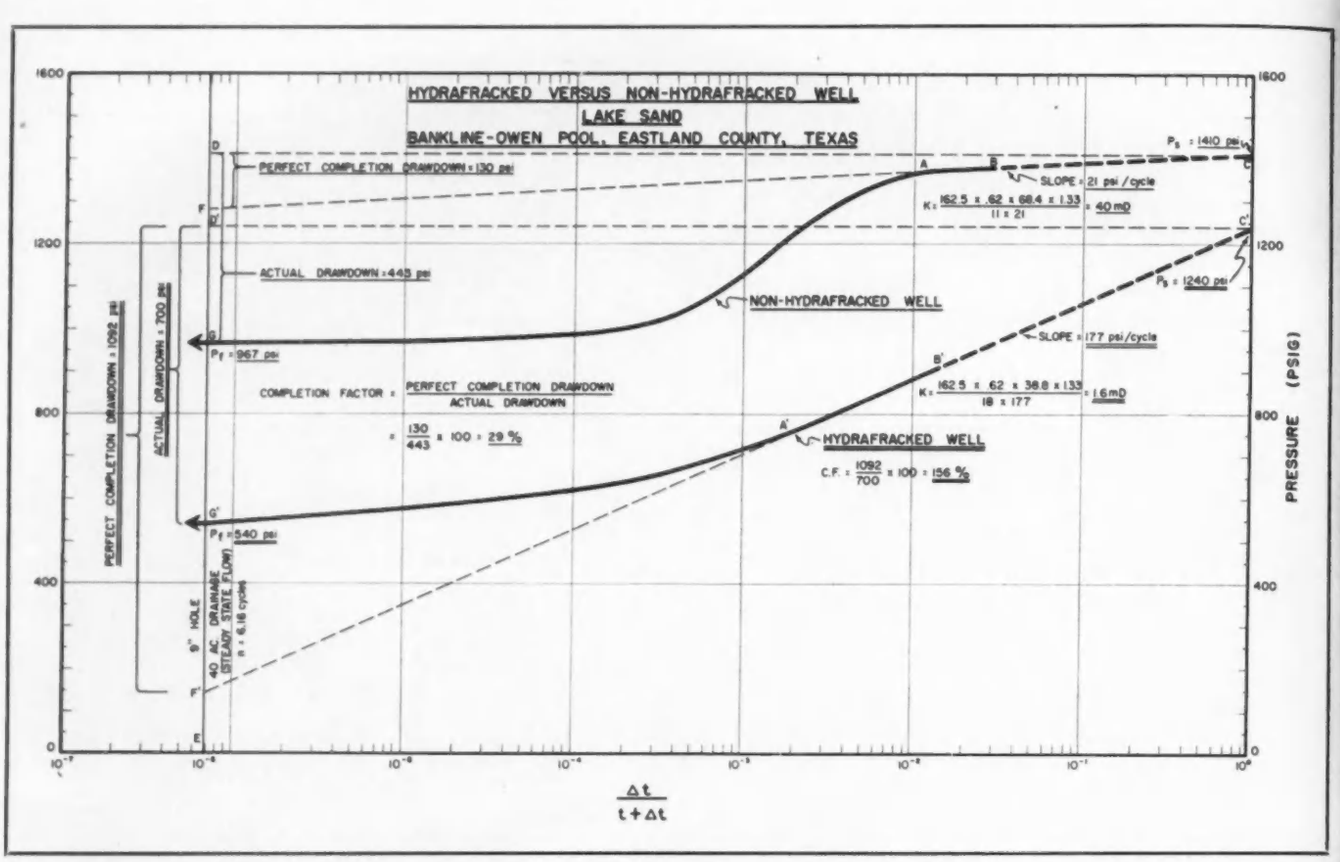

HYDRAFRACKED VERSUS NON-HYDRAFRACKED WELL
LAKE SAND
BANKLINE-OWEN POOL, EASTLAND COUNTY, TEXAS
PERFECT COMPLETION DRAWDOWN = 130 psi
ACTUAL DRAWDOWN = 445 psi
NON-HYDRAFRACKED WELL
SLOPE = 21 psi/cycle
K = 162.5 x .62 x 68.4 x 133 / 11 x 21 = 40 mD
Pi = 1410 psi
Pf = 967 psi
COMPLETION FACTOR = PERFECT COMPLETION DRAWDOWN / ACTUAL DRAWDOWN
= 130/443 x 100 = 29 %
SLOPE = 177 psi/cycle
K = 162.5 x .62 x 38.8 x 133 / 18 x 177 = 1.6 mD
Pi = 1240 psi
HYDRAFRACKED WELL
C.F. = 1092/700 x 100 = 156 %
Pf = 540 psi
PERFECT COMPLETION DRAWDOWN = 1092 psi
ACTUAL DRAWDOWN = 700 psi
9" HOLE
40 AC. DRAINAGE
(STEADY STATE FLOW)
n = 6.18 cycles
PRESSURE (PSIG)
Δt / t+Δt

Fig. 4—Effects of hydraulic fracturing in the Bankline-Owen field of Eastland County, Texas, are evaluated in this example. Data were obtained from bottom-hole pressure buildup curves on two producing wells.

ing relationship for the theoretical drawdown was derived:

$$p_s - p'_f = \frac{q\,\mu}{2\,\pi\,kh}\left[\ \ln\,(r_e/r_w) - \tfrac{1}{2}\ \right] \ldots\ldots\ldots\ldots\ldots (6)$$

This relationship is much simpler than the one derived for the non-steady state case in section "B" and is therefore to be preferred when the porosity (f) is not accurately known or when a free gas phase is known to be present in the reservoir, which complicates determination of the compressibility (c). It is further known (references 1, 2, 3, 4) that the slope of the straight line portion of a bottom-hole pressure buildup curve on semilog paper Z, (expressed as pressure increase per 10-cycle), is related to the past production rate (q) and the transmissibility coefficient $\frac{kh}{\mu}$ of the formation as:

$$Z = \frac{q\,\mu}{2\,\pi\,kh} \cdot \frac{\ln 10}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Combination of equation (6) with equation (7) and substituting

$$\log r_e/r_w = \ln r_e/r_w \div \ln 10 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

leads to the following expression for the theoretical drawdown:

$$p_s - p'_f = 2\,Z \log (r_e/r_w \cdot e^{-.5}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

and since $e^{-.5} = .6065$ for the completion factor:

$$CF = \frac{\text{theoretical drawdown}}{\text{actual drawdown}} = (2 \log .6065\ r_e/r_w)\left(\frac{Z}{p_s - p_f}\right)_{psi} (100)\ \text{percent} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

As shown on Figure 1, this means graphically an extension of the slope $Z_{(psi)}$ in psi/ cycle to the left over a distance of 2 log .6065 r_e/r_w cycles from the point where $\frac{\Delta t}{t+\Delta t} = 1$ to find the theoretical drawdown (FD) and dividing this by the actual drawdown (GD) to find the completion factor. Values for 2 log .6065 r_e/r_w for different values of spacing and borehole radius are given in the text.

B. Under-saturated reservoirs of large extent. For this type of reservoir, van Everdingen's non-steady state case for compressible fluid flow is most applicable. For this condition (ref. 4, eq. 11) the following expression for the actual drawdown at shut-in time t is derived:

$$p_s - p_f = \frac{q\,\mu}{2\,\pi\,kh}\left[\ \tfrac{1}{2}\ln t + 0.4045 + S\right] \ldots\ldots\ldots (11)$$

and for the pressure drawdown a time increment Δt later (ref. 4, eq. 14):

$$p_s - p_{(t+\Delta t)} = \frac{q\,\mu}{2\,\pi\,kh} \cdot \tfrac{1}{2} \ln \frac{t+\Delta t}{\Delta t} \ldots\ldots\ldots (12),$$

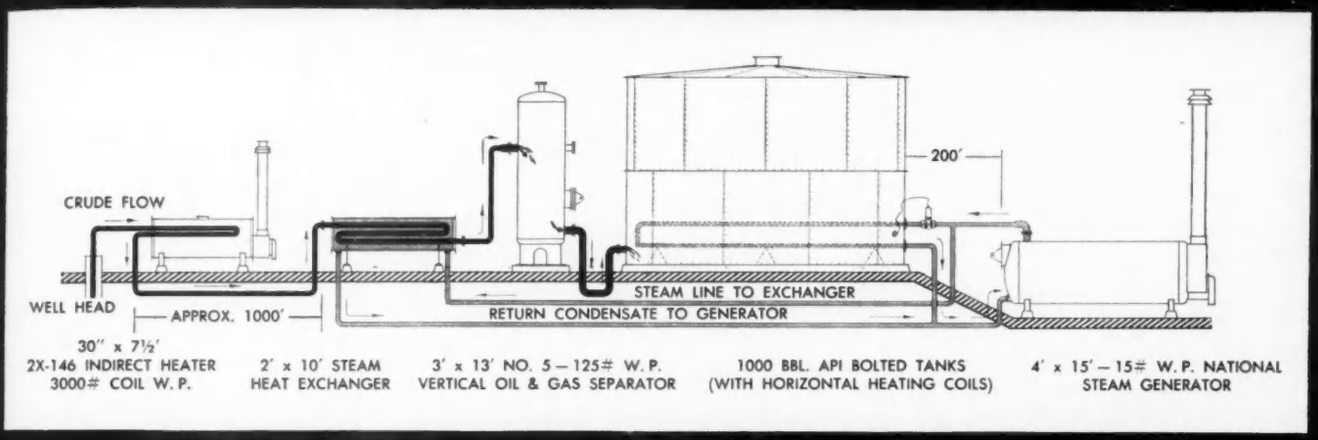
so that the pressure increase since shut-in time at $t+\Delta t$ is:

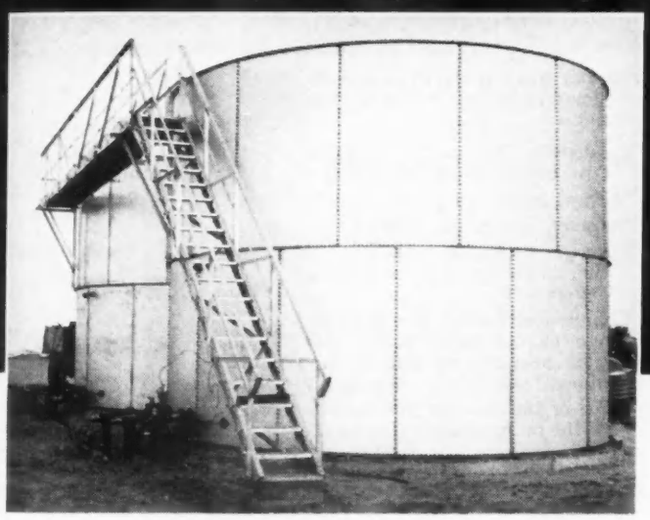
$$p_{(t+\Delta t)} - p_f = \frac{q\,\mu}{2\pi\,kh}\left[\ \tfrac{1}{2} \ln \frac{t \times \Delta t}{t+\Delta t} + 0.4045 + S\ \right]. (13)$$

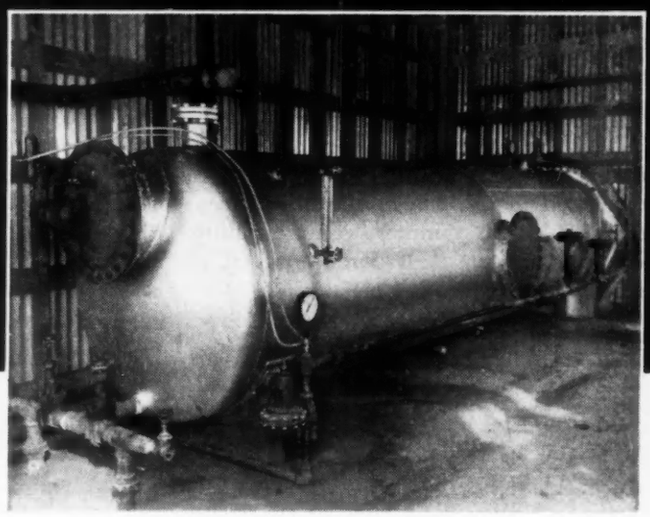
It will be obvious that the term $\ln \frac{t \times \Delta t}{t+\Delta t}$ will approach zero when the ratio approaches one. This will take place when Δt approaches unity and when t may be considered as very large compared to Δt. In other

PRODUCTION PROBLEM SOLVED IN UINTAH COUNTY NEAR VERNAL, UTAH

Problem — To handle 240 barrels per day of 37-degree gravity oil with a pour point of 90-degrees.







Solution — National Tank Company equipment is set as per the above flow diagram. An indirect heater is set at each well head for a flow line heater in order to keep production at a high enough temperature to prevent congealing in the lines. Before separation, the production is subjected to an additional heat through a Steam Heat Exchanger so that gas can properly be separated from the oil in the oil and gas separator. Each tank is thermostatically controlled at a temperature of 110° preparatory to being shipped by truck as there is no pipeline connection available at present time. A 4' x 15' two million BTU 15# W. P. National Steam Generator is installed along with coils in each tank to keep the production to 110-degrees in the stock tanks. This is a closed system with the generator set at a lower level than the tank grades and the condensate line buried from the tanks back to the unit. Atmospheric temperatures in this area range sometimes as low as 40° below zero in the winter months.

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

words, the ln term will vanish for a value of time one dimensionless unit after the well is shut in. When the pressure at this moment is designated as $p_{(\underline{t}+\underline{\Delta t})}$, the pressure increase since shut-in will be:

$$p_{(\underline{t}+\underline{\Delta t})} - p_f = \frac{q\,\mu}{2\,\pi\,kh}\left[0.4045 + S\right] \quad \ldots\ldots\ldots\ldots (14)$$

The value of $p_{(\underline{t+1})}$ is according to equation (12):

$$p_{(\underline{t+1})} = p_s - \frac{q\,\mu}{2\,\pi\,kh} \cdot \tfrac{1}{2}\ln \underline{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

so that the extra pressure drop caused by the skin (S) is:

$$\frac{q\,\mu\,S}{2\,\pi\,kh} = p_s - p_f - \frac{q\,\mu}{2\,\pi\,kh}(\tfrac{1}{2}\ln \underline{t} + 0.4045) \quad \ldots\ldots\ldots\ldots (16)$$

and the theoretical drawdown (actual drawdown minus skin effect):

$$p_s - p_f - \frac{q\,\mu\,S}{2\,\pi\,kh} = \frac{q\,\mu}{2\pi\,kh}(\tfrac{1}{2}\ln \underline{t} + 0.4045) \quad \ldots\ldots\ldots\ldots (17)$$

Since:

$$\frac{q\,\mu}{2\,\pi\,kh} = \frac{2\,Z}{\ln 10}, \quad \underline{t} = \frac{kt}{f\mu c r_w^{\,2}} \quad \text{and} \quad \log X = \frac{\ln X}{\ln 10},$$

the completion factor can now be expressed as:

$$CF = \frac{\text{theoretical drawdown}}{\text{actual drawdown}} = \left(\log \cdot \frac{0.809 \cdot kt}{f\,\mu\,cr^2}\right)\left(\frac{Z}{p_s - p_f}\right)(100) \text{ percent} \quad \ldots\ldots\ldots\ldots (18)$$

This equation is expressed in centimeter-gram-second units associated with Darcy's law. If the pressures are expressed in psi, the permeability (k_{mD}) in millidarcies, time (t_{min}) in minutes, compressibility (c_{psi}) in vol./vol./psi and the well bore radius $r_{w(in)}$ in inches, the relationship reads:

$$CF = \left(\log \frac{.001421\,k_{mD}\,t_{min}}{f\,\mu\,c_{psi}\,r^2_{w(in.)}}\right)\cdot\left(\frac{Z}{p_s - p_f}\right)_{psi}(100) \text{ percent} \quad \ldots\ldots\ldots\ldots (19)$$

In graphical terms, this means extending the slope Z_{psi} in psi/cycle to the left over a distance equal to log $\frac{.001421\,k_{mD}\,t_{min}}{f\,\mu\,c_{psi}\,r^2_{w(in.)}}$ cycles from the point on the right-hand side of the chart where $\frac{\Delta t}{t + \Delta t} = 1$ to find the theoretical drawdown (FD) and dividing this by the actual drawdown (GD) to find the completion factor. The ratio $\frac{k_{mD}}{\mu}$ can be obtained from a knowledge of the slope Z_{psi} and the production rate as discussed in the text.

NOMENCLATURE

	Symbol	Unit
Pseudo-production time until shut-in (cum.÷avg. rate)	t	seconds
Same	$\underline{t}$	dimensionless
Same	t_{min}	minutes
Time well has been shut in	Δt	seconds
Same	$\underline{\Delta t}$	dimensionless
Same	Δt_{min}	minutes
Permeability	k	Darcies
Same	k_{mD}	millidarcies
Porosity	f	fraction
Viscosity	μ	centipoises
Compressibility of the reservoir fluid	c	vol./vol./atm.
Same	c_{psi}	vol./vol./psi
Radius of the well bore	r_w	centimeters
Same	$r_{w(in)}$	inches
Drainage radius of the well	r_e	centimeters
Rate of production (res. conditions)	q	cm³ per sec.
Same	$\underline{q}$	dimensionless
Same	$q_{(b/d)}$	stock tank barrels per day
Cumulative production from well	N_p	barrels
Formation volume factor	B	dimensionless
Static bottom hole pressure	p_s	atmospheres
Same	$p_{s(psi)}$	psi
Flowing bottom hole pressure, actual	p_f	atmospheres
Same	$p_{f(psi)}$	psi
Flowing bottom hole pressure, theoretical	p'_f	atmospheres
Bottom hole pressure after shut-in time $\underline{\Delta t}$	$p_{(\underline{t}+\underline{\Delta t})}$	atmospheres
Bottom hole pressure, one dimensionless unit of time after shut-in	$p_{(\underline{t+1})}$	atmospheres
Pressure drop per unit rate of flow caused by the skin	S	dimensionless
Natural logarithm (base e)	ln( )	
Common logarithm (base 10)	log( )	
Damage factor, the fraction of the drawdown to overcome damage	DF	fraction
Completion factor, the percentage of the theoretically possible productivity actually obtained	CF	percent
Slope of the straight line portion of the buildup curve	Z	atm. per cycle
Same	$Z_{(psi)}$	psi per cycle
Formation thickness	h	centimeters
Same	h_{ft}	feet
Number of cycles to extrapolate slope on buildup curve Z in order to find theoretical drawdown	n	

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—The End

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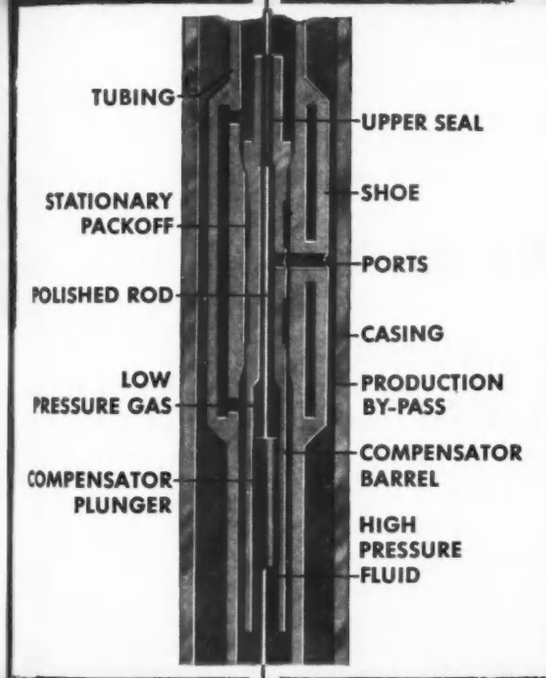

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WATER-FLOOD EXPERTS of this panel provided answers to many questions asked at a recent "quiz forum" held in Bartlesville, Okla. These experts are, from left to right, Frank Beach, Cities Service Oil Company, Bartlesville; Weldon Baker, Halliburton Oil Well Cementing Company, Oklahoma City; Tom Harris, Mid-Continent Petroleum Corporation, Tulsa; Jack Powell, Bureau of Mines, Bartlesville; D. B. Taliaferro, chief of Secondary Recovery division, Bureau of Mines, Bartlesville, who directed the meeting; Bruce Grant, Sinclair Research Laboratories, Inc., Tulsa, moderator; Curtis Moutrey, president, Curtis Moutrey and Associates, Tulsa; David Bartlett, Kenner Oil Company, Tulsa; Stuart Milam, Phillips and Milam, Chelsea, Okla.

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The Experts Discuss Water-flooding

This panel provided the answers to some practical questions asked at a recent "quiz forum" on water-flood operations.

WATER-FLOOD OPERATORS from the Mid-Continent area, at a recent "quiz forum" held in Bartlesville, Okla., kept a panel of experts busy answering questions involving a wide range of subjects connected with water-flooding techniques.

The meeting was sponsored by the Bureau of Mines at Bartlesville, under the direction of D. B. Taliaferro, chief of the Bureau's secondary recovery section at Bartlesville. Eight experts from independent and major oil companies as well as from the service companies made up the panel.

Highlights of the program are presented in the following question and answer digest of the meeting:

Q. *What is the best method of aeration for Arbuckle supply water?*

A. Some operators find the spray type aerator satisfactory. In one instance an operator had previously used a draft-type aerator but discarded it because the trays required too frequent cleaning. In the spray-type system now in use the water supply well is located approximately 600 feet from the settling pond. The well is presently being produced with a large volume pump through three-inch tubing. The water flows through three-inch plastic pipe into a section of transite pipe in which brass nozzles have been placed.

Q. *What factors determine whether a sour brine can be handled in a closed system?*

A. The chief factor is the presence of hydrogen sulfide. The quantity of hydrogen sulfide present in the water has a definite bearing on the economic use of water in a closed system. The presence of barium or strontium and the temperature of the water also seems to make a difference. It has been noticed that the quality of the Arbuckle water varies greatly throughout the Mid-Continent area.

Q. *If barium sulfate is present in return water would it be more ad-*

vantageous to use an open-type water-treating system?

A. If it is present in large quantities, it can be precipitated by the addition of sulfates. A few operators have found that the use of metaphosfates has been effective in minimizing the possibilities of plugging by barium or strontium sulfate.

Q. *What are the best methods for controlling bacteria in (1) open systems, (2) closed systems?*

A. The use of chlorine has been successful. It would be an advantage to reduce the chlorine demanded by oxidizing the materials that chlorine would oxidize. In a closed system, the chlorine demand would be high. Some of the bactericides that have been marketed recently, have proved effective in some areas, but not effective in others. Many companies are doing research work on these products at the present time.

Q. *What is the future of cement-lined pipe in water flooding as compared to plastics or other corrosion resistant material?*

A. Cement-lined pipe is not the complete answer to everything. Wherever a section of line is not cement lined or the cement lining is cracked, corrosion results. Plastic pipe is unsatisfactory in secondary recovery operations because of lack of strength. Working pressures were found to be too low. One company hopes to have a plastic pipe on the market soon with working pressures of from 500 to 1000 pounds per square inch. Plastic pipe is smooth and deposits do not form on it, whereas cement-lined pipe is rough and collects deposits of paraffin and scale.

Q. *Is it possible to learn to "fracture" so that the fractures are vertical through the entire sand bed? Will this be an advantage in developing a water-flood?*

A. Yes, the vertical fracturing process has been used sufficiently to prove that in most cases vertical fractures can be created. Vertical fracturing definitely would be advantageous in flooding a laminated section having continuous shale streaks or barriers.

Q. *After fracturing is it possible to determine whether the fractures are vertical or horizontal?*

A. Two methods, injectivity profiles and radioactive tracers have been used to determine, or attempt to determine, the direction of the fractures. In this particular case, the injectivity profile would probably tell more than the radioactive tracer.

Q. *What results have been obtained from hydraulic fracturing wells in water-flood?*

A. According to one operator, increases of 100 percent or more have been obtained from fracturing oil wells in a water-flood that had been in operation for several years. Another operator reported that the production from one lease, where the oil wells had been fractured, increased in the course of a year. He stated further that they were always worried about channeling through to input wells, but that they had never had channeling, at least not a drop in pressure at an input well because of fracturing. However, over a period of time the input pressure will drop slightly, probably because fracturing has made it easier for the fluid to flow into the well bore. It was also noticed that the water-to-oil ratio dropped after fracturing on many of the wells because the oil production increases more than the water production.

Q. *What factors should be considered in determining the optimum fracture load?*

A. Some of the factors that should be considered are well spacing, sand thickness, and permeability of the formation. However, instead of using 1 large fracture, 2, 3 or 4 fractures using a smaller amount of material and the multiple fracture treatment can be used. This treatment creates a fracture and plugs it off with some type of material and creates another one in some other spot. By this method the radial penetration would not be so great for any one fracture.

Q. *What is the effect of fracturing on a well that had been previously shot with nitroglycerin?*

A. If the well had been shot, as a large number have been, then in all probability it would result in more than one fracture, as a great number of fissures would already exist in the well. It would enlarge several of them and if a multiple fracture treatment was used the result would be the plugging off of all of the fractures that have been opened and the opening of smaller ones in the same area and in a higher zone. Multiple fracturing could be repeated as many times as desired and the number of times it would be beneficial would be difficult to predict. Probably 3 or 4 different attempts to fracture would be sufficient. In a well that has not been shot, the consensus is that multiple fracturing would result in only one fracture per treatment.

From the treating pressures being used in northeastern Oklahoma and southeastern Kansas, fracturing is probably creating only one fracture and extending that fracture. If a large number of small fractures were being extended, the treating pressure probably would be less than in the case where one fracture is being created or enlarged.

Q. *If the well had not been shot because of the laminated nature of the Bartlesville formation, why would one not get a multiple fracture result?*

A. In that case, the bedding plane being the weakest point, once a fracture was started, it would require less pressure to extend that fracture than it would be to create a new one.

Q. *Would a higher injection rate be an advantage in fracturing the Bartlesville sand?*

A. One would have to consider whether the well had or had not been shot. If the well had been shot, the higher injection rate

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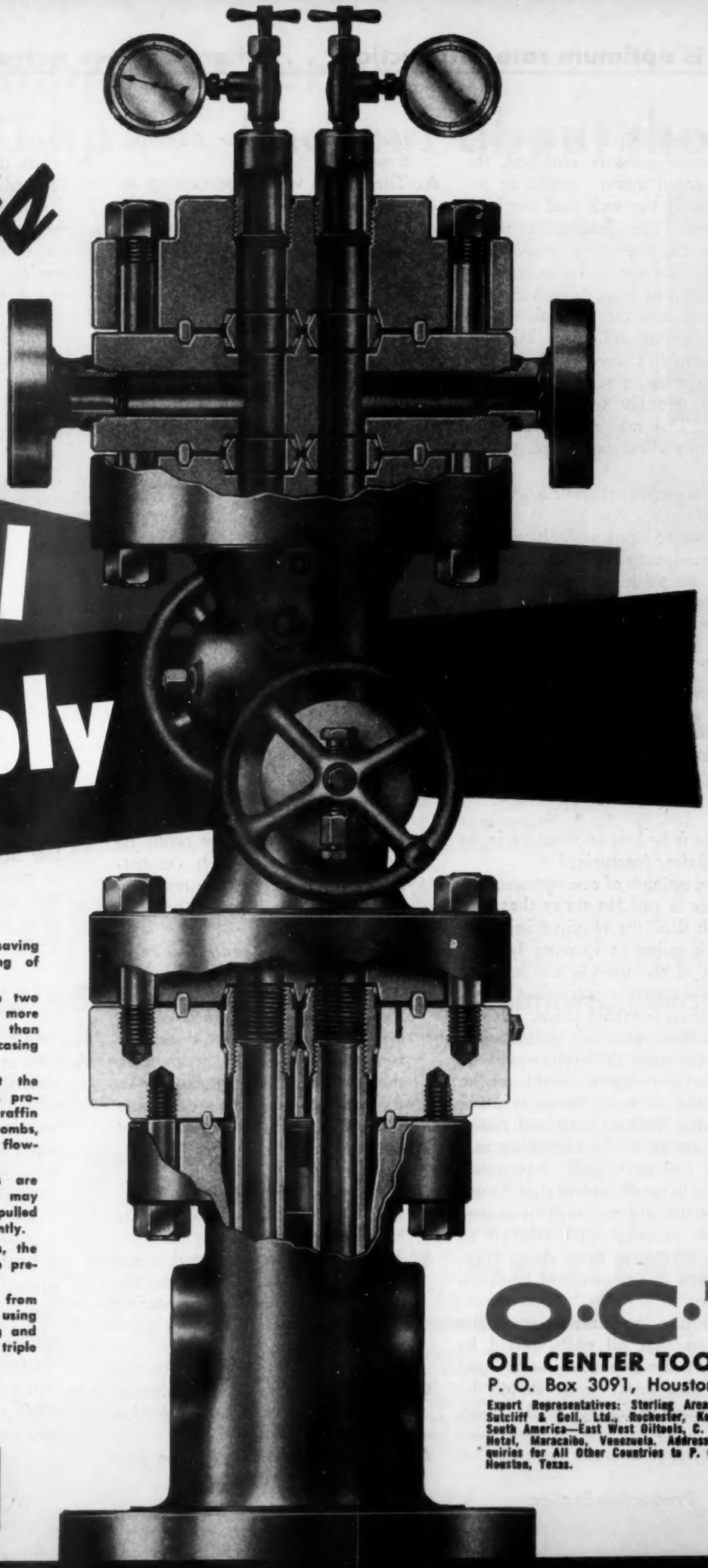

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would definitely be an advantage. The more pressure obtained, the more small fissures would be extended. If the well had not been shot and if the operator was working on one fracture at a time, the main factor would be to have an injection rate high enough to carry the sand into the formation without plugging off. The injection rate wouldn't have much bearing on plugging, since that is done mechanically with a plugging agent. The rate doesn't seem to have any effect on the plugging.

Q. *Have water-input wells been fractured?*

A. Yes, water-input wells have been fractured very successfully. However, the thickening agent can be used successfully only with fresh water or water of very low salinity.

Q. *What is the smallest pipe size through which a fracture job has been done?*

A. Normally it is effected through two-inch tubing, but there may be some exceptions where smaller pipe were used.

Q. *Would it be best to shoot an input well before fracturing?*

A. In the opinion of one operator the answer is no. He states that if a well is shot, the required injection rate is going to increase because much of the fluid is lost in parts of the formation other than where fracturing is taking place.

Another operator's opinion was that shooting the well would be beneficial in that it would aid the injection of water in parts other than the fracture itself, but rather than use all of the fracturing material (oil and sand) that would be lost in small fissures that do not materially aid the well, it is preferable to use a small fracture in wells that have been shot. Thus, the area of fracture will be much smaller.

Another operator was of the opinion that oil wells should be shot at the beginning of a flood and that input wells should be shot later in the life of the flood.

Q. *What effect does the rate have on the efficiency of the fracturing treatment?*

A. The rate is very important up to the point where it is no longer possible to put sand into the formation. This condition is called "sand out." In a number of sands, the rate required is rather high because of the permeability found in the formation after the fracture travels a short distance from the well bore. This opens up considerable permeability and fluid is being lost to the formation quite rapidly without extending the fracture. These cases can result in a sand out.

Q. *Is fracturing down two-inch cement-lined tubing liable to end in disaster?*

A. It would be very hazardous because it would be very easy to crack the cement, and that of course, would destroy the value of the cement-lined pipe. The decreased inside diameter of the pipe will increase the treating pressure over what would be normally expected, because of increased friction.

Another operator was of the opinion that fracturing could be done through two-inch cement-lined pipe where pressures were not too high to damage the pipe.

Q. *Would fracturing cause erosion of the cement lining in the pipe?*

A. The erosion effect of the sand on the pipe has been argued considerably, but there doesn't seem to be very much scouring action from the sand because of the coating or film of fluid around the sand and the rounded surface of the sand particles.

Q. *Is it preferable to shoot a producwell before resorting to fracture treatment?*

A. In developing a new flood it appears preferable to shoot in the conventional manner. Fracturing may be resorted to later as a remedial measure.

Q. *Can the water-to-oil ratio be controlled by varying the injection rates?*

A. In shallow water-floods, the produced water is definitely reduced when the rate of injection is decreased. Also near the end of the flood when the water production increases, the volume of water produced can be decreased by reducing the rate of injection, but the rate of oil production decreases at the same ratio.

Q. *What is the optimum rate of injection?*

A. There are two extremes, one of which is to put in all the water possible at pressures short of the parting pressure and recover as much oil as quickly as possible. The other extreme is to put the water in at a slower rate and operate the flood over a long period of time. Proponents of the faster rate of injection, approximately 10 barrels of water per foot of exposed sand in the well, think it is more economical to complete the flood as quickly as possible and keep ahead of corrosion and equipment failure problems that gradually affect all water floods.

Proponents of slow flooding, 1 to 2 barrels of water per foot of sand thickness, think that by using low injection rates the peak rate of production lasts longer, while fast injection of water results in more rapid water break through to the oil wells.

Q. *What effect does curtailment have on the oil production from a water-flood?*

A. One operator had to shut down a water-flood making 300 barrels of oil a day for a period of 15 days because of a labor strike. When water injection was resumed, the rate of oil production had decreased to 2000 barrels daily. After a year of operation the rate of production reached the original rate of 3000 barrels daily. However, in the meantime the flood had been extended and whether or not oil production came back after the shut down is questionable. The operator believes that approximately 1000 barrels of oil per day was lost as a result of the shutdown.

—The End

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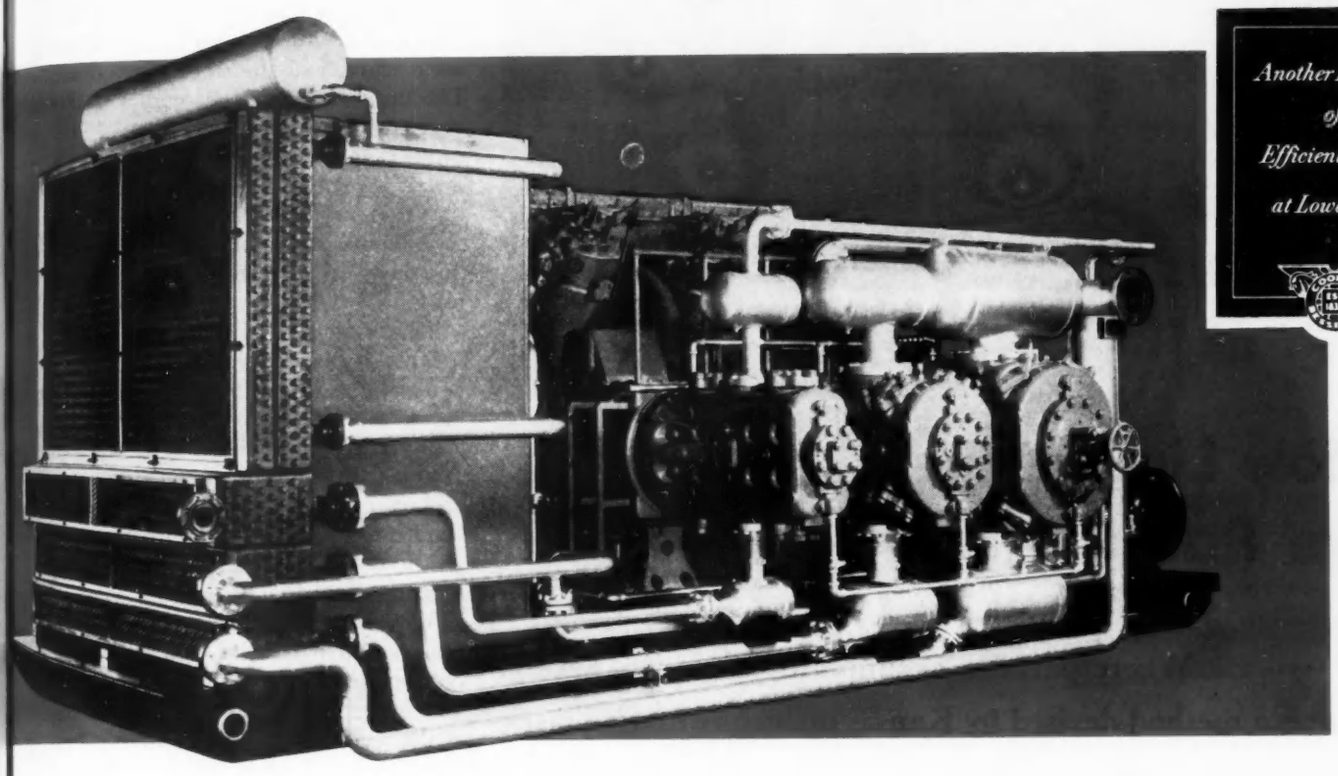

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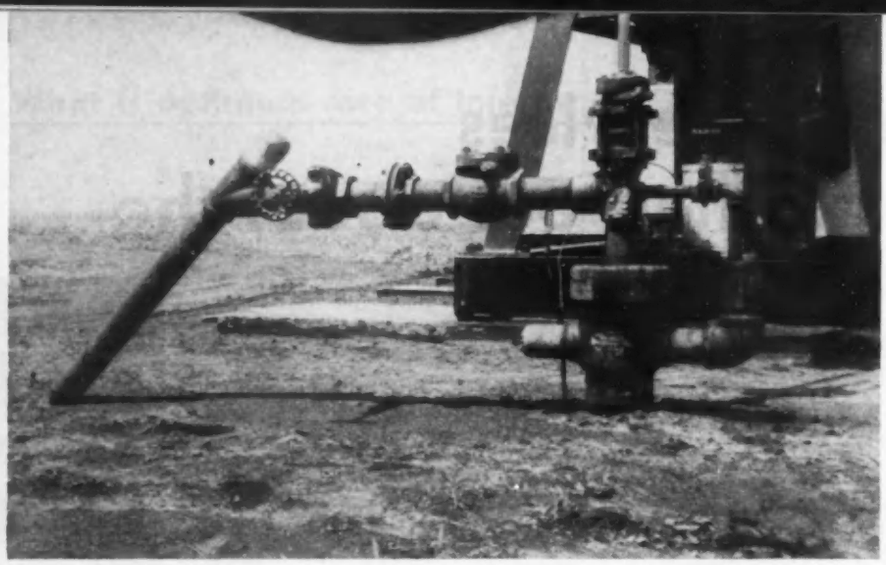


Fig. 1—Wellhead hookup showing position of 45-degree tee for introducing a plastic ball to chase paraffin out of the flow line.

Flow Line Rigged For Paraffin Pigs

Where paraffin accumulations are not severe, here is a method devised by Kansas operators to use plastic balls to clean buried pipe.

A SIMPLIFIED AND inexpensive system for paraffin control has been developed by several operators in Western Kansas. The idea involves the use of plastic or rubber balls which are encased in interlocking chain links. By incorporating several features in the flow lines, these balls may be introduced at the wellhead and recovered in a specially-designed trap located at the tank battery.

The wellhead connection shown in Figure 1 was made by installing a swing check valve on the nipple leading from the tubing head so that the ball does not have to travel through it. A union was installed at the same level so that it would be above the ground and convenient to disassemble if necessary. The gate valve was installed in front of a 45-degree tee fitted with a bull plug for the insertion of the plastic ball. Some bull plugs have a quarter-inch tap and gage so that pressure buildup can be detected easily.

A bleeder line was installed on the other side of the tubing head. On wells that make no gas, this bleeder line is turned down into a swaged nipple leading from the casing head to catch waste oil and run it back down the casing. This also makes a convenient connection for dumping corrosion inhibitor and paraffin solvents.

Figure 2 shows the arrangement on the other end of the flow lines for catching the pig or plastic ball. A piece of eight-inch pipe was fitted with three-inch collars welded on the side for as many wells as the operator plans to add to the present battery. Three-inch collars were welded on both ends, with one end fitted in the same manner as the side connections. The opposite end contained a baffle to keep the ball inside the trap. A top connection was made to provide a means of recovering the ball. A quarter-inch petcock welded on the side enables the pumper to bleed the pot down so that the ball can be removed.

This system was installed as the separator was hooked up. The outlet with the small baffle was connected to the separator inlet line. The other connections were tied into flow lines using 45-degree ells to allow easy passage of the paraffin removal balls.

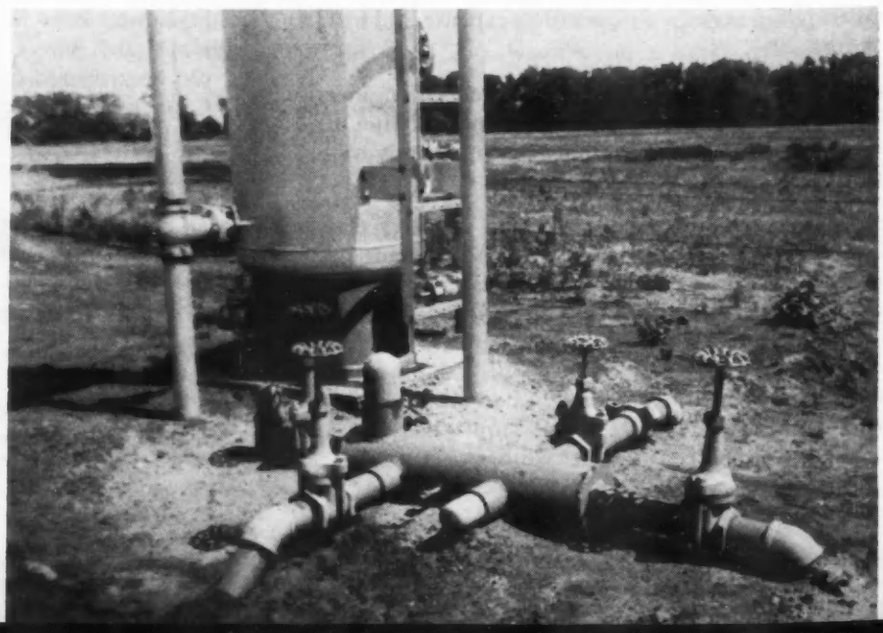
These plastic balls are run through the flow lines as often as necessary to keep the lines free of paraffin.

They are run at least once a year, usually when the first cold snap hits. On severe cases, a slug of paraffin solvent is poured into the upright tee at the wellhead before the plastic ball is placed in the line. This goes ahead of the ball and works out any constrictions which may have accumulated during the interim since the last ball was run.

The well usually is allowed to head up just before the purging operation so that the flow line will pressure up immediately and a gauge on the wellhead will show the pumper just how much pressure is being developed.

—**The End**

Fig. 2—Simple chamber made from eight-inch casing serves as a trap to catch balls at the tank battery. Note 45-degree ells on connecting lines.



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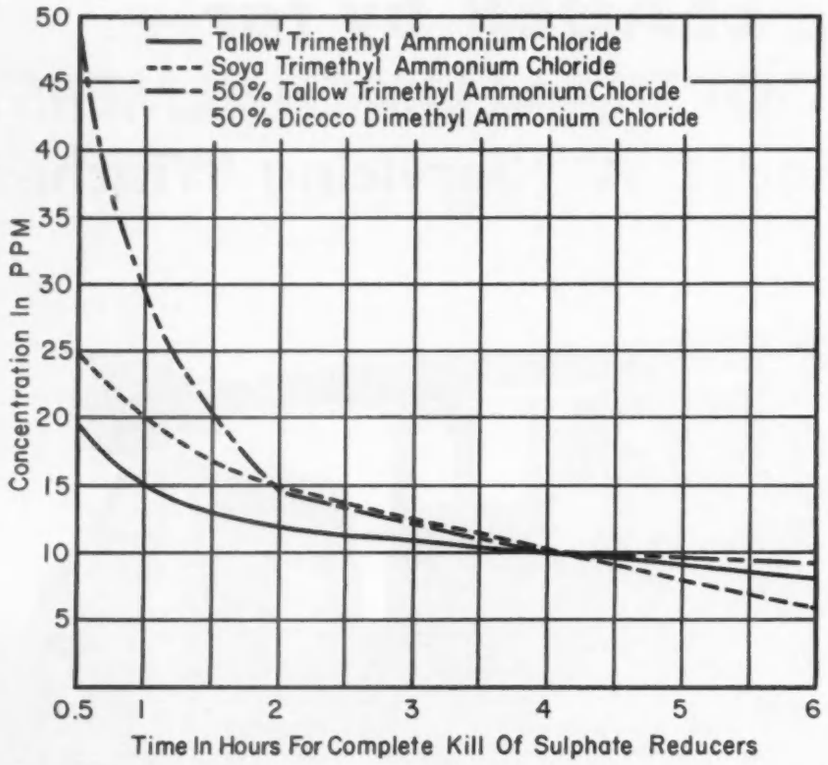

CONCENTRATIONS of quaternary compounds used in testing kill power on sulfate reducing bacteria at 20° C.

Inhibiting sulfate reducing bacteria controls . . .

Corrosion In Water-flood And Disposal Systems

By C. D. LaSUSA, Petroleum Technical Service, Chemical Division, Armour & Company, Chicago

BY SUCCESSFULLY inhibiting sulfate reducing bacteria, quaternary ammonium compounds are proving extremely beneficial in water-flooding and water disposal systems. These quaternary ammonium salts of fatty amines which have recently become available to the oil industry, prevent pore plugging and permit larger volumes of water to be injected into the formation under lower pressures.

Only in recent years has the damage caused by bacteria in waters used for injection or disposal purposes been ascertained. Before the beneficial action of the quarternaries was established, water-flood operators experienced considerable difficulty when injection pressures increased and injection rates decreased. This condition was first attributed to corrosive products which plugged the sand faces. This led to the use of corrosion inhibitors both to protect the injection systems and prevent plugging. However, corrosion in many water systems became most difficult to control and the fact was recognized that some other interfering agent was responsible, especially when it was discovered that inhibitors against hydrogen sulfide failed to stop corrosion.

Sulfate reducing bacteria. Discovery of the presence of sulfate reducing bacteria (desulfovibrio desulfuricans) provided the explanation. The bacteria found was a particular kind that reduces sulfate ions, thus producing hydrogen sulfide continuously, which reacts with iron and produces black, insoluble, finely divided ferric sulfide. This ferric sulfide is deposited in the sand pores and causes plugging which makes it more and more difficult for injection waters to pass through into the reservoir.

Quaternaries do not function as protein oxidants, such as chlorine, nor as systemic poisons, such as arsenicals. These new bactericides are surface-active agents and they function probably by adsorption at the surface of the bacterial cell and by interference with the cell metabolism. Unlike other bactericides, the sulfate reducing bacteria as yet have not displayed resistant strains when waters are treated with quaternaries.

Since this new method of corrosion control is dependent upon surface activity, well known principles of surface chemistry may be applied. Here, as in numerous other instances, it is apparent that of the quaternaries available to the flood operator, certain ones have specific bactericidal action against sulfate reducing bacteria.

Primary plus secondary quaternaries. Outstanding success has been obtained with several of the quaternaries derived from primary amines containing from 12-18 carbon atoms in the alkyl chain. In initial experiments, soya and tallow derived compounds, being least expensive, were selected for more extensive work. These compounds did not prove to be the final answer because their corrosion protection is low. About the same time it was found that normal fat-derived dialkyl dimethyl ammonium chlorides (secondary quaternaries) have excellent action as corrosion inhibitors for acid in water systems. Although these possess good bactericidal activity, generally they are not as good as the primary quaternaries. This led to a simple and logical conclusion. Perhaps the desired properties of each could be obtained merely by mixing them. This was tried and proved sucessful. Corrosion protection was greater than 95 percent, and complete inhibition of growth of bacteria and algae has been obtained with as little as six parts per million of each of these materials in fresh waters.

Field application. One of the most outstanding features of the quaternaries is their versatility. They have been used successfully in nearly all fields where sulfate reducers have ap-

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peared. At the present time, 27 flooding operations in the tri-state area of Illinois, Indiana and Kentucky are treating with the quaternaries. Success in both fresh and produced water has been attained. Largest of the flooding operations in Oklahoma found the quaternaries to be the only method to treat the bacterial problems successfully and economically. Quaternaries have been used in brine waters of Kansas for about three years. Arbuckle and Douglas waters in various areas of Oklahoma have not proved too aggressive for the quaternaries to handle, and several projects in the clay swelling sands of California are being treated with quaternaries. Several high brine waters in West Texas have been responding to treatment for two years.

Several field tests are shown below:

Test A. An Eastern Oklahoma flood system was treated with quaternary for 29 days. Plates were installed near the end of the first 24 hours of quaternary feed. The inhibitor was fed at the pumping plant continuously by a chemical feeder pump.

Waters. Mixed fresh and salt water.

Treatment: One day at 50 ppm of active quaternary. Three days at gradually reduced concentrations from 50 to 10 ppm. Eight days at 10 ppm of active quaternary. Eighteen days at approximately 0.65 ppm of active quaternary.

Results:

	Percent Loss in Test Coupon Weight No Treatment	With Quaternary	Percent Reduction in Corrosion
Location 1	* 1.7150	0.0067	99.5
Location 2	** 0.6088	0.1410	76.8

* Location 1—2700 feet of line from pumping station. 1014 bbls. of fluid passed over coupons.

** Location 2—6800 feet of line from pumping station. 6350 bbls. of fluid passed over coupons.

Clearing of the red turbid waters indicates the injection of quaternaries effected complete bacteria and algae control.

Test B: An Eastern Kansas flood system was treated with quaternary for a period of 30 days. Plates were installed during the first 24 hours of quaternary feed.

Water Analysis:

Sodium	2150 ppm
Calcium	323
Magnesium	87
Bicarbonate	132
Sulfate	29
Chloride	4042
Total Solids	6763 ppm

Treatment: One day at 50 ppm of active quaternary. One day at 25 ppm of active quaternary. Two days at 15 ppm of active quaternary. Ten days at 10 ppm of active quaternary. Sixteen days at 5 ppm of active quaternary.

Results:

	Percent Loss in Test Coupon Weight No Treatment	With Quaternary	Percent Reduction in Corrosion
Location 1	* 5.494	0.317	94.3
Location 2	** 0.8664	0.0427	95.0

* Location 1—2700 feet of line from pumping plant. 9940 bbls. of fluid passed over coupons.

** Location 2—9000 feet of line from pumping plant. 8615 bbls. of fluid passed over coupons.

The solid black water in the injection system cleared after injecting quaternary, this improvement indicating that the sulfate reducing bacteria probably are also under control. Water meter trouble which had been experienced was practically eliminated.

Field treatment. Initial treatment of waterfloods or water disposal systems with quaternaries should be made on a "slug treatment" basis. Fifty ppm of active quaternary is recommended for the first day of operation. This high initial concentration provides optimum killing of the large numbers of bacteria generally present in untreated systems. It also provides for conditioning of the system (pipe, etc.). Conditioning of the system is the adsorption of a thin film of the quaternary on to the metal surface to give corrosion protection and also to kill bacteria in pipe connections, under scale, etc. This adsorption phenomena is characteristic of all cationic surface active agents. The same results can be obtained at lower initial concentrations but more time will be required.

After the first day of treatment the concentration should be gradually reduced to the minimum effective concentration for bacteria and corrosion control. This is generally five to 10 ppm active quaternary.

In general, the addition of the quaternaries is made as close to the water supply as possible. This technique protects the greatest amount of pipe line and associated equipment, and since the quaternary concentration is not diminished through its action, it is wise to take advantage of this added benefit. Attention also should be given to the filter since it has been found to be a good breeding place for the bacteria. Slug treatment from time to time should establish control.

Not perfect inhibitor. Nearly all bactericides have some drawbacks and quaternaries are not an exception. Some produced waters contain very high magnesium and calcium ion concentrations and there is evidence that these ions interfere with the action. This necessitates using higher concentrations and, of course, increases cost. Other tests involving ion concentrations indicated that the sodium and potassium cations exhibit little or no effect on the bactericidal action of the quaternary. This has been verified from field experience.

To date, anions have not become a major factor in lowering the bactericidal activity. The sulfate ion in some cases causes a slight decrease, but as yet there is no evidence to indicate detrimental effects due to chlorides, nitrates, carbonates and phosphates. Considerable work is under way to develop a satisfactory bactericide which will not complex with the cations mentioned in the above paragraph. Preliminary reports from the Armour Bacteriological Laboratory indicates progress in this direction. Laboratory and field work should be completed soon.

Killing power tests. Plant run samples of the above mentioned quater-

TABLE 1

COMPOUND	Test No.	ppm. Tested	ppm Giving Kill 0.5 Hr.	1 Hr.	2 Hr.	4 Hr.	6 Hr.
Tallow derived alkyl chain	1	2-5-10-15-25	25	25*	25	25	15
	2	2-5-10-15-25	25	25*	25	15	10
	3	5-10-15-25-50	25	15	10	10	10
	4	5-10-15-25	15	10	10	5	5
	5**	5-10-15-25-50	10	15	5	5	5
	6	5-10-15-25-50	10	10	5	5	5
Soya derived alkyl chain	1	2-5-10-15-25	15	25	10	10	5
	2	2-5-10-15-25	25*	15*	15	10	10
	3	2-5-10-15-25	25*	10*	25	15	5
	4	5-10-15-25-50	50	25	15	10	5
50-50 mixture tallow derived and coco derived.	1	5-10-15-25-50	50*	25	15	10	5
	2	5-10-15-25-50	50	50	15	5	5
	3	5-10-15-25-50	25*	25	15	15	15
	4	10-15-25-50	50	25	15	15	15

* Parts per million of germicides giving complete kill, or less than 50 survivors as denoted by *, of desulfovibric at various time intervals.

** Test 5 and 6 are duplicates.

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naries were submitted for testing against desulfovibrio desulfuricans, which is typical of the sulfate reducing organisms. This group of gram-negative, non-spore forming, anaerobic rods are common in oil well waters and water storage systems.

A killing test of 20° C. with exposure periods of 0.5, 0.1, 2.0, 4.0 and 6.0 hours and various concentrations of the germicides was used. One milliliter of a 1:2 dilution of a four or five-day old culture of the desulfovibrio was added to 10 milliliter of the germicide held at 20° C. This gave a count of about 4 million cells per milliliter in the medication mixture. At the appropriate time intervals 0.5 milliliter of the medication mixture was pipetted into tubes containing about 10 milliliter of melted agar. The tubes were incubated 12 days at 30° C. and read after 3, 6 and 12 days to obtain colony counts before the entire tube was blackened with hydrogen sulfide.

Results of these tests are listed in Table 1.

It should be noted that these tests were conducted on a count of about four million cells per milliliter of medication mixture. This imposes killing conditions which probably would not be encountered in the majority of use applications. It is probable that a reduction of cells in the medication mixture will decrease the required killing concentrations of the germicides.

In summation, performance-wise a completely satisfactory corrosion inhibitor and bactericide for sulfate reducers has been developed for fresh water systems. Quaternaries can be used economically in most produced waters where the calcium and magnesium ion is low. Action of the same quaternaries in brines is satisfactory, but again in some cases it is necessary to use higher concentrations. Although the cost of commercial grade quaternaries is relatively high ($0.37-$0.90 per pound), the use concentration of 4-15 ppm greatly offsets this disadvantage. Treatments normally average from 1-3 mils per barrel, depending upon the type water treated.

ACKNOWLEDGMENT

The author wishes to thank R. R. Burns, Dr. L. L. Bott, Dr. L. A. Harriman, Dr. W. S. Ogilvy, K. Blazys and B. E. Marsh for assistance in the preparation of this article.

—The End

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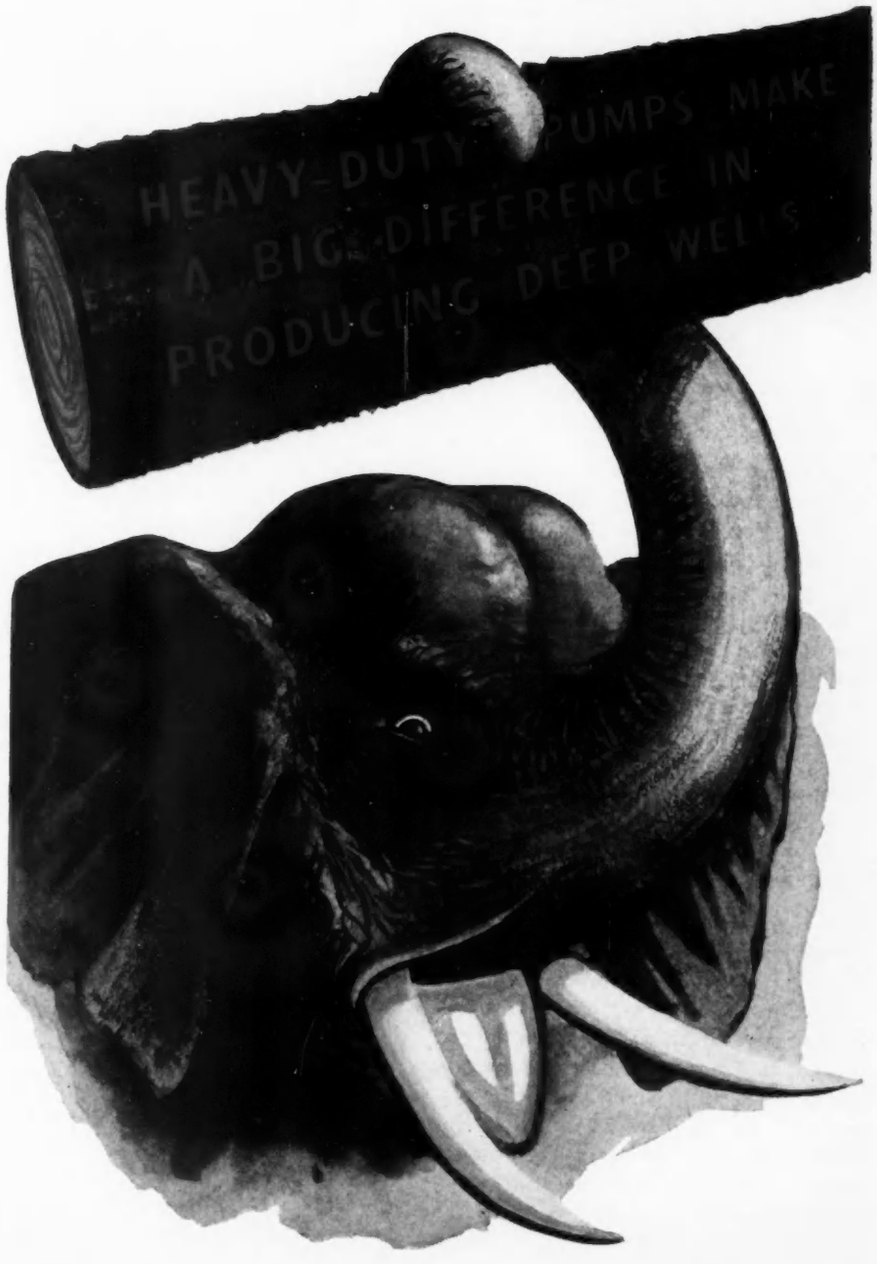

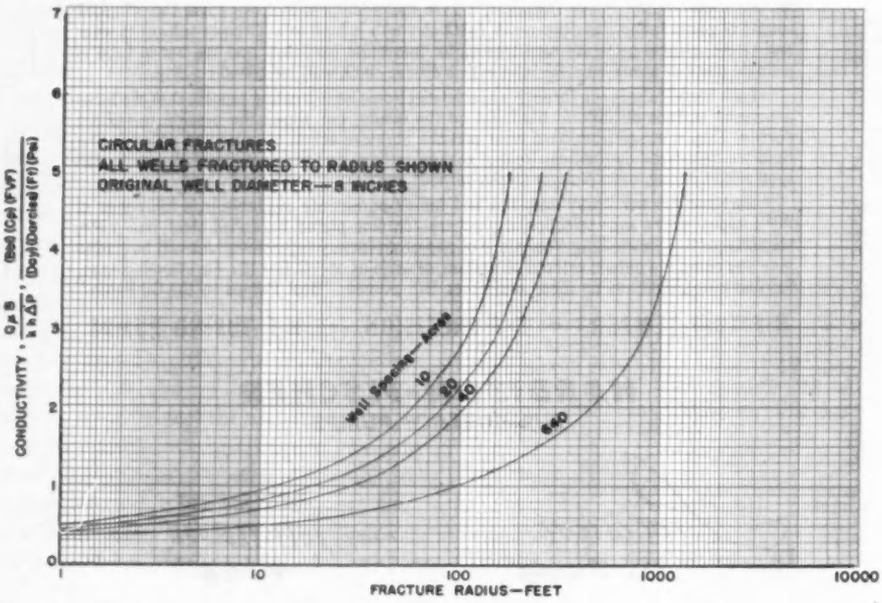

Fig. 1—Conductivity of horizontally fractured thin reservoirs—direct and staggered line-drive patterns.

Water-flooding and gas cycling affected by . . .

Horizontal Fractures In Thin Reservoirs

Part 8: Conductivity of direct and staggered line-drive patterns.

By DR. PAUL B. CRAWFORD, Texas Petroleum Research Committee, Texas A & M, College Station, Texas

COMMERCIAL RESERVOIR fracturing techniques are being employed regularly to increase the well production rate during primary production. Fracturing also is indicated for certain water flooding and gas cycling programs. Principal benefit in these applications is to increase the conductivity of the pattern. By creation of fractures of desirable radii it may be possible to achieve large swept areas in a fairly short period of time. Purpose of this investigation was to estimate the conductivity of the direct line drive and staggered line drive patterns when the wells were fractured to various radii.

Analysis of problem. Conduction model experiments have indicated that the creation of a circular horizontal fracture in a thin reservoir resulted in substantially the same conductivity as that which would be observed if the well were reamed to the radius of the fracture. The model which was used for this study was approximately 20 inches wide by 30 inches long and filled with a dilute salt solution to 3/8 inch to 3/4 inch in height. The corresponding reservoir thickness would be approximately 7 to 15 feet for a 10-acre spacing. Corresponding thicknesses may be calculated for other well spacings. The circular fracture was simulated by a thin copper sheet which was soldered to the well or wells located at opposite ends of the line drive pattern. It was found that little variation occurred in the conductivity of the pattern by raising or lowering the simulated horizontal fracture.

Observations were made at steady state conditions for a uniform homogeneous conducting medium. Results apply to actual reservoirs only in such proportion as the analogue corresponds to the actual conditions in the reservoir.

Inasmuch as circular isopotentials normally exist around the well of each unfractured pattern and the fact that the creation of a circular or "pancake" fracture will result in a circular isopotential whose radius is equal to that of the fracture, it immediately follows that for certain considerations the creation of the fracture will produce substantially those results which would occur if the well were reamed to the diameter of the fracture.

Having determined experimentally that such would exist for thin reservoirs it is possible to use existing equations to calculate the effect of fracture radius on pattern conductivity. The equations for performing this were presented by Muskat and Wyckoff[1] in 1934. Their equations will apply where the existing isopotentials about an unfractured well are fairly circular. The conductivity of elliptical fractures may be calculated provided it is known that the fractures correspond to the shape of a normally existing elliptical isopotential. Irregular shapes may be studied on a steady state electrical model.

Pattern conductivity. The conductivity of the direct line drive and staggered line drive patterns may be calculated by Muskat and Wyckoff's[1] equation:

$$\frac{Q\mu\beta}{kh\,\Delta p} = \frac{2.255}{\frac{d}{a} - 1.17 + \frac{2}{\pi}\log\frac{a}{r_w}}$$

Q = injection or production rate, bbl/day
μ = viscosity, cp.
β = formation volume factor
k = permeability, darcies
h = pay thickness, ft.
Δp = pressure differential, psi
a = pattern width, ft.
d = pattern length, ft.
r_w = well radius, ft.

The above equation has been used to estimate the conductivity of horizontally fractured thin reservoirs. The results are shown in Figure 1. It will be noted that the data apply for the case in which all wells are fractured to the indicated radius. The original well diameter was 8 inches. It will be noted that for an unfractured 10-acre spacing the conductivity is estimated to be near 0.48. If fractures of 10 feet in radius are created at each well the conductivity of the pattern will increase to a value 0.9. The conductivity of the pattern will be doubled if the radii of the fractures are near 15 feet. Previous work has indicated the desirability of creating fractures in a 10-acre spacing of approximately 30 to 50 feet in radius. It will be noted that the conductivity for such a system may be expected to be near 1.25 to 1.6.

If the radius of the fracture in-

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creases beyond 100 feet it will be noted that a fairly sharp increase in pattern conductivity is to be expected. An eight-fold increase would be expected if the radius of the fractures was near 200 feet. An infinite conductivity would be expected if the radius of the fractures was equal to 330 feet. In this case, interconnections would occur, and the sweep efficiency would be near zero.

Conductivity of the 20-acre pattern is shown to be near 0.46 if no wells are fractured. If all wells are fractured to a radius of 10 feet the conductivity is expected to be near 0.8. The conductivity is expected to be doubled when the radius of the fractures is equal to 18 feet. It will be noted that between the range of 40 to 80 feet that the conductivity of the pattern is expected to be near 1.25 to 1.55. For fractures greater than 150 feet in radius a rapid increase in conductivity is to be expected as the radius of the fracture increases.

Conductivity of the unfractured 40-acre pattern is indicated to be near 0.44. The conductivity is expected to be doubled if the radius of the fracture is near 20 feet. Fractures of 100-foot radius at all wells will result in a conductivity near 1.6. There is a rapid increase in pattern conductivity as the radius of the fracture increases beyond 200 feet. An infinite conductivity is expected to occur when the radius of the fracture is 660 feet.

Conductivity of the unfractured 640-acre pattern is near 0.38. The conductivity is expected to be doubled when the fracture radius is increased to 50 feet. Fractures in the range of 250 to 400 feet are expected to result in conductivities of 1.3 to 1.5. It will be noted that fractures of 1000 feet in radius may be expected to result in a conductivity of 2.6. This is approximately seven times more conductivity than the unfractured pattern.

It may be determined from Figure 1 that a fractured 20-acre pattern may be flooded or cycled in a shorter time than would be required for an unfractured 10-acre pattern. For example, it will be noted that if an unfractured 10-acre pattern is to be flooded or cycled, it will have a conductivity near 0.5. For the 20-acre pattern to be flooded or cycled in the same time the conductivity must be approximately twice as great as that of the 10-acre pattern.

From the chart it will be noted

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that the conductivity of the 20-acre pattern will be approximately 1.0 when the fracture radii are equal to 20 feet. This will permit the flooding or cycling of the 20-acre pattern in approximately the same time as that which may be required for the unfractured 10-acre pattern. It is conceivable that a fractured 40-acre pattern may be flooded or cycled in the same length of time as would be required for simultaneously flooding or cycling four unfractured 10-acre units.

In order for the 40-acre pattern to be flooded or cycled in the same time as the unfractured 10-acre patterns, it will be noted on the chart that fractures of approximately 150 feet must be created at each well. Under these conditions the conductivity of the pattern is near two, which is approximately four times that of the unfractured 10-acre pattern. Fractures larger than 150 feet could result in the completion of flooding or cycling programs in shorter periods of time. Similar comparisons may be made for the 640-acre spacing.

Conclusions. The conductivity of horizontally fractured thin reservoirs has been estimated for the direct and staggered line drive patterns. The data apply only insofar as the flow of fluids in the reservoir conform to the assumptions required in this work.

For thin reservoirs it is shown that the creation of a "pancake" fracture will have substantially the same result as reaming the well bore to the given diameter insofar as pattern conductivity is concerned. Creation of fractures of approximately 15, 18, 20 and 50-foot radii will result in conductivities of approximately twice that for the unfractured 10, 20, 40 and 640-acre well spacings, respectively.

It is conceivable that the creation of fractures may permit the flooding or cycling or larger patterns than are normally used. This could require fewer wells in the development of a pressure maintenance program. Creation of fractures may also permit the flooding or cycling of thinner pays than has been profitable heretofore.

—The End.

ACKNOWLEDGMENT

The author wishes to thank Dr. George H. Fancher, director of Texas Petroleum Research Committee, for encouraging this work, and the Research Committee for permission to publish the results of this series. Henry Ince prepared the illustration.

REFERENCE

[1] Muskat, M., and Wyckoff, R. D., "A Theoretical Analysis of Water Flooding Networks," AIME Trans., Vol. 107, P. 62 (1934).

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Fig. 1—Brine sample for analysis is taken from sweet oil and gas distillate well.

Fig. 2—Inserting test coupon in flow line at well head.

Oil Well Corrosion Can Be Licked

Industry's annual bill of about $1 billion can be cut substantially by applying these mitigation measures.

By S. A. HUCKLEBERRY, Product Engineer
Dowell Incorporated, Corpus Christi

THE PETROLEUM INDUSTRY suffers corrosion losses of approximately a billion dollars annually. Corrosion of oil and gas equipment is the result of a number of different factors. The two principal causes may be classified as:

- Galvanic corrosion
- Chemical corrosion

Regardless of which type of corrosion is responsible, the result is the same: Expensive well equipment is dissolved. Tubing, casing and pump parts frequently are severely damaged. Corrosion damage to pumps is especially costly, severe damage to ball and seat valves reducing producing efficiency and necessitating frequent replacement.

Preventive measures. A number of different methods have been utilized for minimizing galvanic corrosion—the use of sacrificial anodes; insulating flanges to electrically isolate pipe; standardization of metal composition in all well equipment, and plastic coating of metal parts.

The problem of chemical corrosion by naturally occurring acids in well fluids has been combatted by the use of chemical inhibitors to protect the exposed metal surfaces. The inhibitor is lubricated into the well in liquid form (or occasionally in solid sticks, which dissolve slowly, prolonging the application), where it plates out over the surface of the exposed metal in a monomolecular film, protecting the metal from the action of the well fluids.

Field testing of inhibitors. An oil operator using an inhibitor to control subsurface chemical corrosion is interested naturally in the effectiveness of such an inhibitor. To properly evaluate the efficiency of protection, it is necessary to determine the rate of chemical corrosion, and/or the amount of corrosion that has already taken place in the well. A number of methods are available for obtaining this information. The principal ones used are:

- Analysis of water samples
- Corrosion tests on metal coupons
- Running caliper surveys
- Using sub joints
- Visible inspection

Since most of the dissolved iron present in a water sample is the result of corrosion of subsurface well equipment, the iron content of the sample provides a good basis for estimating the severity of the corrosion taking place in the well. Samples of the brine produced from the well are analyzed for total iron. (Figure 1.) This method can be used successfully only in sweet oil and gas distillate wells. It cannot be used in the presence of hydrogen sulfide due to the chemical reaction of H_2S and iron, resulting in the precipitation of the iron.

The reduction in iron content of the brine samples, following inhibitor treatment, provides some indication of the effectiveness of the inhibitor being used. It must be remembered that some formation brines naturally contain a small percentage of dissolved iron. In such cases, bottom-hole water samples should be obtained and analyzed. This naturally occurring iron content should then be subtracted from the total iron determinations used to estimate corrosion.

Use of steel test coupons has proved to be of great value in estimating the amount of corrosion taking place in a well. These test coupons, rigidly held in a special holder and electrically insulated from the rest of the well, are suspended in the well head or flow lines. (Figure 2.) After a period of 2 to 6 weeks in contact with the well fluids, coupons are removed and the weight loss occurring during the test period determined. Metal loss of the coupons is measured in MPY (mils per year) or IPY (inches per year). Validity of test results is assured by the use of duplicate test coupons. Care

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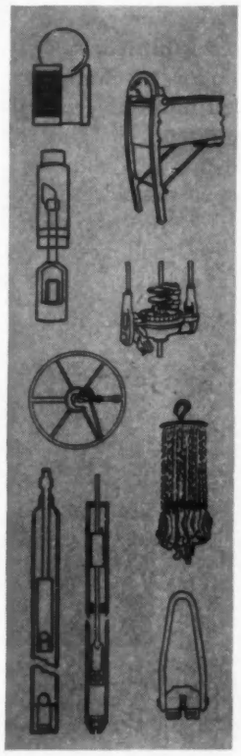

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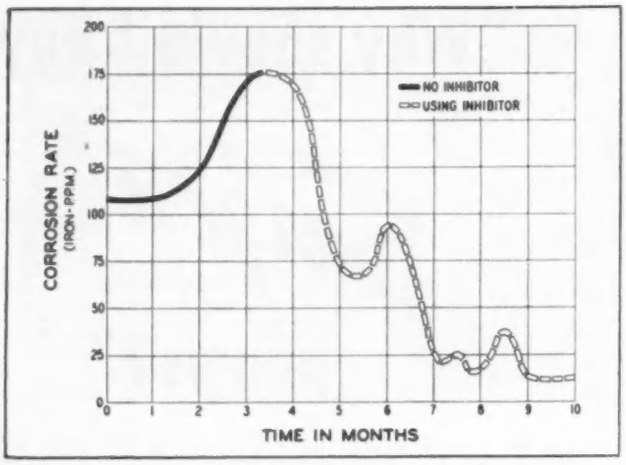

Fig. 3—Corrosion rate of high-pressure gas condensate well before and after treatment by iron content in produced water.

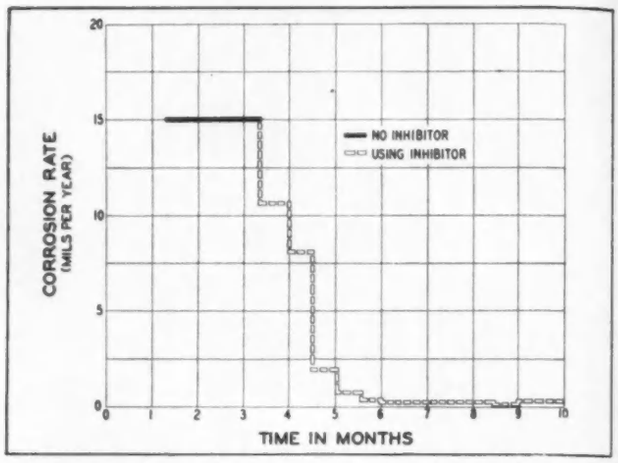

Fig. 4—Corrosion rate in same well as Figure 3 before and after treatment as indicated by coupon tests.

must be taken in conducting these tests, not to touch the metal coupons with the bare hands as this will tend to accelerate corrosion. Corrosion rate data obtained by this method represents merely the corrosivity of the well fluids at that particular point in the well, and should not be taken as representing the total amount of corrosion in the well.

A caliper survey can be used to indicate the condition of the inner surface of casing or tubing. Presence of serious pitting can frequently be detected by this method.

Equipment subject to contact with corrosive well fluids may also be visually inspected at intervals. This examination is necessarily limited to coupons and well head equipment, or pipe strings during round trips to the surface.

It is important that adequate records be kept of all corrosion tests, in order to properly evaluate the effectiveness of any inhibitor program conducted on a well. These may be kept in different ways, depending upon the preference of the operating company. Many companies are content to limit their testing to caliper surveys.

Field application. A typical case history illustrating the use of an inhibitor to reduce subsurface corrosion is a high-pressure gas condensate well. A test with metal coupons revealed to the operator that corrosion was taking place in the well at the rate of .015 inches per year. This high rate of corrosion was verified by analysis of water samples from the well.

A program of corrosion prevention, utilizing a semi-polar organic inhibitor was undertaken. Corrosion tests made during the subsequent months revealed, as a result of using the inhibitor, the corrosion rate of the metal in the well diminished rapidly. Within three months, the operator was satisfied that, on the basis of additional tests, corrosion in the well had virtually ceased. The extent of corrosion reduction as indicated by the corrosion tests, is shown in Figures 3 and 4.

Economics of inhibitors. The use of organic inhibitor to eliminate corrosion in a well must be economical in order to be practical. The inhibitor should not cause any damage to the well. Plugging, discoloration of produced fluids, or the formation of oil-brine emulsions will result in extra cost to the operator.

Labor cost in conducting such an inhibitor treatment program can and should be held to a minimum. In many instances, the regular lease man can conduct treating without taking up too much additional time. Several companies have found it profitable to hire men to do nothing else but treat wells against corrosion.

A principle factor in a corrosion prevention program is to see to it that the well is treated properly. Unless treating recommendations are followed, excess inhibitor will be wasted, or on the other hand, inadequate treatments may result in insufficient protection for the well equipment.

Naturally the cost of the inhibitor is a factor in determining the economics of such a program. In most cases the cost of the material is negligible in comparison with the extended life of tubing and casing, as a result of the protective inhibitor.

A number of operators have reported that they are treating wells at a cost of between 50 cents a day and several dollars a day. In gas distillate wells, the average treating cost is close to 50 cents per million cubic feet of gas produced. Each operator should calculate the probable life of the tubing as compared to that of the reservoir. He should also estimate how much it would cost him to treat the well. If the cost of treating the well amounts to more than the loss of production due to down time, a workover rig, plus metal replacements and the possibility of losing the well, then it would not be sound economics to use any kind of inhibitor. However, more and more companies are accepting the suggestion that it is less expensive to prevent corrosion than it is to correct it. —**The End**

About the Author

S. A. HUCKLEBERRY is product engineer for Dowell Incorporated, at Corpus Christi, Texas. Born in Oklahoma, Huckleberry graduated from college in 1933. He joined Dowell in 1941 in the district office at Seminole, Okla. He was later transferred to Oklahoma City as office manager. In 1948 he was appointed sales engineer and transferred to Corpus Christi. In 1950 he was promoted to his present position.

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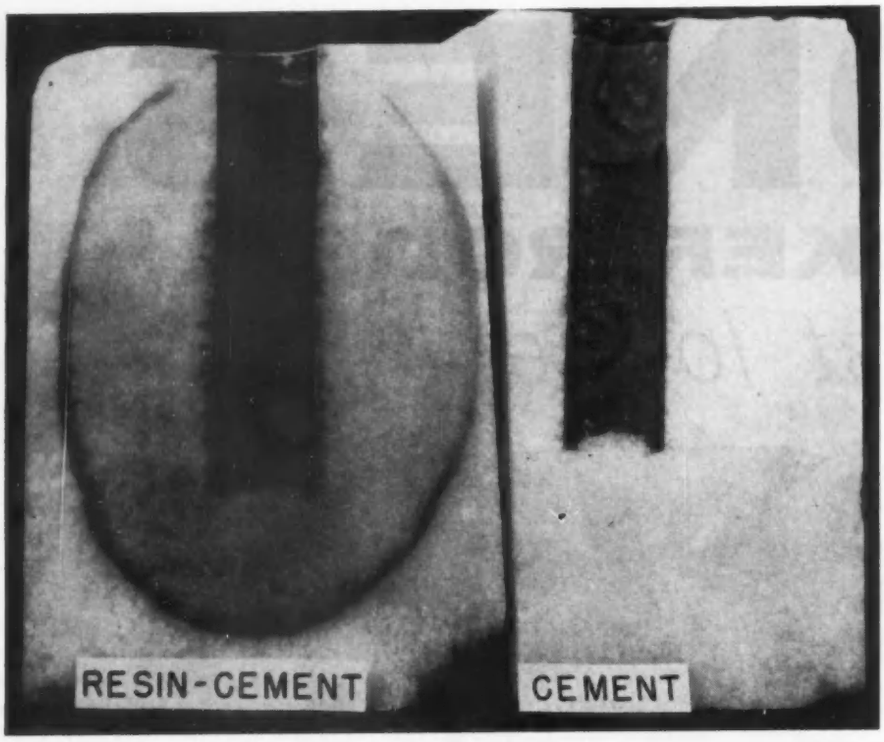

Fig. 1—Penetration and setting properties of a resin-type cement plug compared to that of a conventional cement plug.

Thermo-Setting Resins Used in Squeeze Cementing

- Can penetrate zones of low permeability.
- Used extensively in secondary recovery.

By **ANTHONY GIBBON,** World Oil Staff

Because of their ability to penetrate zones of low permeability, decrease channeling and bypassing, and overcome water coning, resin cements are now being used extensively in secondary recovery operations. First applied for this purpose in Illinois, Indiana and Kentucky, their use is extending into the Mid-Continent area where the less permeable Pennsylvanian formations constitute the greater source of reservoir beds.

Resin cement is a mixture of blended cement, thermosetting resins and water. Fluid lost from the slurry sets up firmly in the penetrated channels, bonding with the main plug and making an impermeable extended zone around it throughout its length as shown in Figure 1.

Physical properties. Resin cement slurries are similar in appearance to a neat cement slurry, weigh about 14 pounds per gallon, and may be handled in the same manner as neat cement except for being mixed in batches. Viscosity is slightly lower than that of ordinary cement slurry, usually not more than 10 poises. High pump pressures are not required to "squeeze" resin from resin cement slurry into a formation. However, pressures comparable to those used with neat cement should be used on squeeze jobs.

Under pressure, a filter cake of cement particles, compacted with a small amount of resin, is formed on the surface of the well bore similar to mud cake deposited during drilling. This filter cake automatically limits the depth of penetration of the resin into the formation. It is usually about one-half inch thick and the fluid resin penetrates and seals radially to about 2½ inches.

Uniform penetration. The cement particles in the slurry tend to give more uniform penetration of the formation throughout the entire length of any open hole being squeezed and to prevent the more permeable zones from taking most of the mixture. Limited penetration also means that the resin will not enter the formation beyond the range of gun perforation. The entire production zone can thus be squeezed off with resin cement and the oil zone perforated later.

The material is not selective and will penetrate and seal oil, gas or water bearing formations. It will set and bond to either limestone or sandstone formations.

When resin cement is being placed in an open hole it is quite often important to caliper the hole to aid in finding the correct volume to use.

Temperature factor. Resin cement is of no value in an oil well unless it will set as a hard, firm mass. The controlling factor in the setting is temperature. Before resin cement is used, the bottom-hole temperature of the well should be determined. The static bottom-hole temperature is often known from temperature logs or other sources, but the circulation of mud, water, or other fluids in the hole, or into the formation, will produce a lower reading. The time necessary for the fluids in the hole to reach the static bottom-hole temperature will vary from several hours to several days. Thus, when placing resin cement in a well, the temperature at the bottom just prior to running is the one that should be used.

Setting characteristics. Resin cement slurries should set in 24 hours and then should be ready for further well operations. A filter cake on the walls of the hole sets first, followed by the resin cement slurry in the hole. The fluid resin squeezed into the formation is the last of the material to

set. For this reason, if the well bore is to be redrilled with only the resin in the formation left in place, a waiting time of 24 hours should be established before drilling.

The set resin cement and the set fluid resin are both permanent in nature. They are not attacked by oil, gas or salt water and resist the action of common acids. For this reason, plugback and shutoff operations when properly effected, are generally permanent and quite impermeable.

Compressive strength of the set material is ample for use in oil wells. The rate at which strength is attained varies with the temperature at which it is set. In general, the three-day strength will be 1000 pounds per square inch or higher. The ultimate strength is attained more slowly than that of neat cement. It can be drilled in very much the same manner and rate as various portland cements.

Pumping through tubing. When pumping resin cement through tubing where pressure is required, a drillable retainer is recommended at all times. The retrievable cementer has not proven successful for resin cement because of the limited dehydration compared to regular cement, and lack of a back-pressure valve.

One final tubing plug should always be used between resin cement and mud or any displacing fluid. Not only does mud and resin cement react to bad advantage, but more can cling to the tubing wall than ordinary cement. If this is not wiped off, possibly half will not reach the formation.

When possible, it is better to place a tubing plug catcher previous to the job, and use two plugs for the job. Reversal of fluid through the tubing forces one or both to the surface. This should always be done with open ended tubing jobs.

When resin cement is placed through open ended tubing it can be pumped to the bottom of the hole, the lower end of the tubing raised to the desired plug height, squeeze pressure applied and the excess material, if any, reversed out through the tubing.

Because of the adhesiveness of resin cements, they should not be used in a well containing two size tubing strings. Neither displacement nor running one size of plug will solve this problem.

Squeezing through perforations. A pumping test should be made to assure that perforations are open and to determine the pressure required to pump into the formation. Resin cements have exceptional possibilities in procuring a shut-off through perforations in friable or easily broken down formations.

Cementing casing. Better jobs are obtained around the shoe joint by following a regular cement job with a definite amount of resin cement. In those cases a bottom-hole plug is used ahead of the portland cement, another between this and the resin cement, then all followed by the top plug. Even if no plug is used ahead of the portland cement, the plug should always be placed between the two types of cement.

Dump bailer method. Resin cements can be placed with a dump bailer. Where successive dumps are necessary time must be allowed for each dump to set. The dump bailer is used chiefly for small volumes or where it is not practical to pump through tubing. When using the dump bailer method of spotting resin cement, all loose material should first be removed from the well and the well fluid must be of sufficient height and weight to prevent fluid or gas agitation of the resin cement after it is placed. Standard dump bailer procedure is observed as with any other material.

This type of open hole plugging is usually done to shut off water or gas coming into the bottom of the hole.

The volume of resin cement to be used as a plug is determined by the size of the hole, length of section to be filled, and amount of material going into the formation. The amount of material which may enter the formation will depend upon the permeability and any possible fractures. Since these factors are usually not known, it is the general practice to increase the calculated volume 25 percent.

The strength of the set material is ample for all wells and the hardness and drilling characteristics are similar to neat cement. Its use has decreased the difficulty in shutting off water and gas.

ACKNOWLEDGMENT

The writer wishes to thank Halliburton Oil Well Cementing Company for the information used in this article.

—The End

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Composite Catalog, Page 3433

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

BAKER *Tools for Today's Operations*

Here are a few of the most outstanding Baker Oil Tools for 1954. Complete details, illustrations and specifications are in your new 1954 Composite Catalog, starting on Page 435, where many other important Baker Products will be found.

▶ No other product has proved so successful for so many applications as the BAKER RETAINER PRODUCTION PACKER, which can be set on tubing, drill pipe, or on a wire line. Look on Page 496 of the 1954 Composite Catalog to learn how it is used for single-zone or dual-zone production; as a squeeze tool for acidizing or cementing; as a tubing anchor and as a bridge plug.

▶ For placing cement slurry, plastic, acid or other fluids, the BAKER RETRIEVABLE CEMENTER provides a safe, positive "Hold-Down Type" Packer which operates mechanically rather than by fluid pressure. Look on Page 495 of the 1954 Composite Catalog.

▶ BAKER CASING BRIDGE PLUGS can be set on tubing, drill pipe, or on a wire line to provide either a permanent or a temporary bridge plug which prevents either upward or downward movement of fluid or gas. Many other advantages are described starting on Page 474 of the 1954 Composite Catalog.

▶ No other product can equal the efficiency of the BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOE for safely floating-in and landing casing strings of any length. Removes bridges, washes the formation, and imparts a "whirling" action to the slurry. See Page 438 of the 1954 Composite Catalog.

▶ With BAKER DIFFERENTIAL FILL-UP SHOES (or Collars) the casing is filled automatically as it is being run, to within 90% of the fluid level of the annulus. Eliminates the dangerous "Ram Effect" which may break down a potential lost-circulation zone. Permits the introduction of the action of a back-pressure valve at the discretion of the operator, for floating (if desired) and for cementing. Ask any Baker office for brochure containing complete details.

▶ BAKER FLEXIFLOW FILL-UP SHOES (or Collars) permit filling the casing automatically as it is being run, while maintaining a relatively constant level of dry (unfilled) casing until the casing has been landed. It is then possible to bring the Bakelite Ball Valve into play as a back-pressure valve for floating and/or cementing when desired. This latest Baker development is illustrated and described in a folder available upon request from any Baker office.

▶ For successfully placing cement or fluid at the place where it will be most effective, the BAKER CEMENT RETAINER has been "standard equipment" in International oil fields for many years. Read of its many uses starting on Page 474 of the 1954 Composite Catalog.

▶ The importance of having the I.D. of casing free from gun-shot burrs, hardened rotary mud and mill scale is evident from the rapidly increasing use of BAKER ROTO-VERT CASING SCRAPERS. Can be run easily and safely on drill pipe, tubing or a wire line, and leaves the "working surface" of casing clean and smooth for all future operations. Look on Page 517 of the 1954 Composite Catalog for details.

▶ When the time comes to center casing *positively*, and provide a uniform annular space for successful cementing, you need BAKER HINGE-LOK CASING CENTRALIZERS. Made in four ranges to exactly meet your casing programs, with many features not found in other centralizers. Interesting facts and illustrations start on Page 462 of the 1954 Composite (or Baker) Catalog.

▶ Controlled removal of the mud cake throughout the intervals to be cemented is positive and safe when BAKER WALL SCRATCHERS are used. The "scratching" action is minimized while running-in, but the spring-loaded wires with maximum reach dig in for best results on the upstroke. See Page 472 of the 1954 Composite Catalog.

▶ Any drilling man will tell you how the BAKER DRILL PIPE FLOAT VALVE lengthens the life of wire lines and brake bands by relieving weight; how it prevents pulling "wet" strings; how it prevents or minimizes accidents in case the drilling string should part. See for yourself on Page 534 of the 1954 Composite Catalog.

Baker Retainer Production Packer
Product No. 415-D

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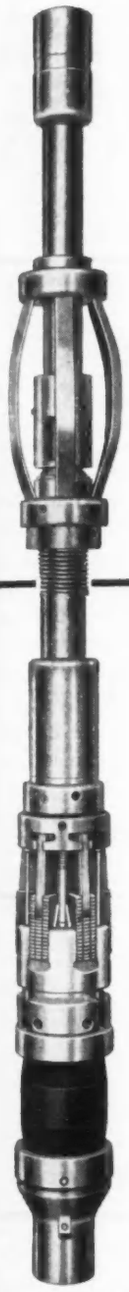

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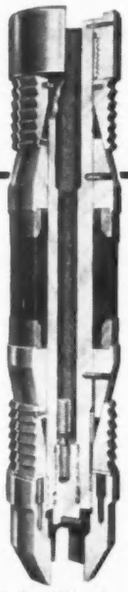

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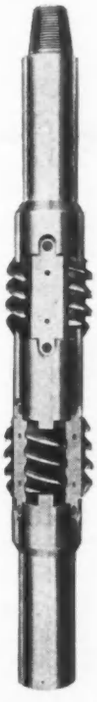
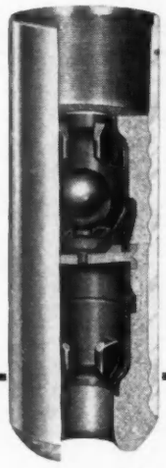


Baker ROTO-VERT Casing Scraper
Product No. 620-C



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Baker HINGE-LOK Casing Centralizer (H-25)
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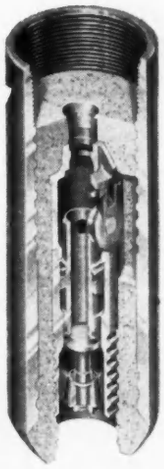

Baker Differential FILL-UP Shoe
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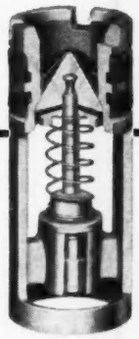

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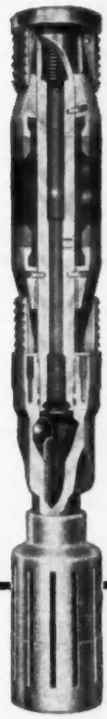

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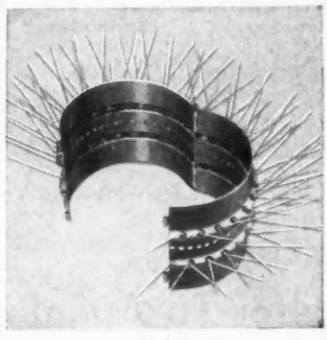
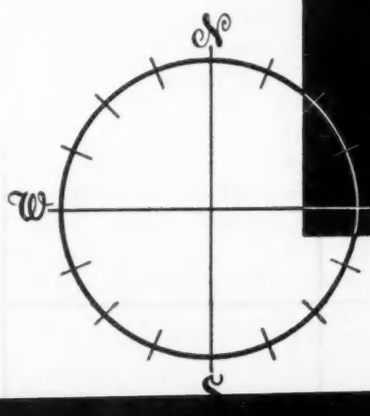


Baker Wall Scratcher
Product No. 900

The Baker Section starts on Page 435 of your 1954 Composite Catalog; or if you prefer a separate BAKER Catalog, contact the office nearest you.



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How to do it

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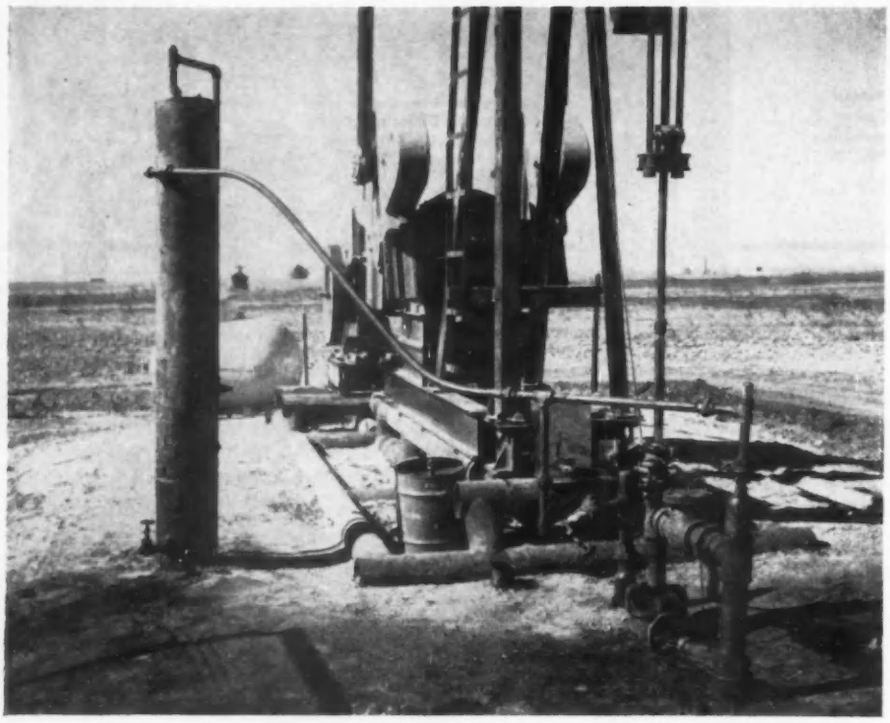
$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Prod-Scrubber for Crude Oil

Use Scrubber To Augment Fuel Gas

When the gas produced with the crude oil is barely sufficient to operate the pumping engine, the supply may be augmented by setting up a scrubber on the flow line and allowing part of the oil to pass back down the casing, allowing the gas to go on into the scrubber and thence to the pumping engine to be used for fuel.

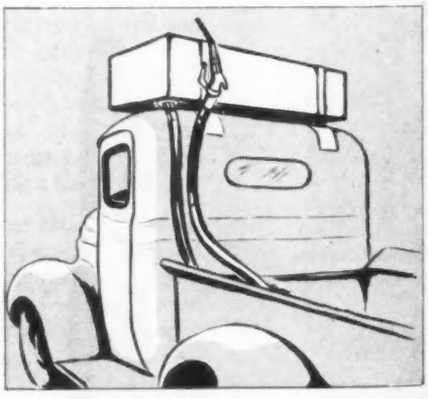
A gas scrubber, made from junked 10 or 12-inch pipe, is set at a convenient point near the wellhead and the outlet on top connected to the fuel line of the pumping engine. The inlet on the side of the scrubber is connected back to the flow line at the tubinghead through a sloping one-inch line so that any entrained liquids will drain toward the well. In the middle of this line, a tee is installed down and connected into the casinghead without any swings or pockets where liquid can collect. This allows all gas that is produced by both the casinghead and the tubinghead to drift upwards into the scrubber and all liquids produced to either stay in with the production on the flow line or drain back down into the casinghead where it can be pumped out again with the virgin crude.

In operation, the valves are all closed when the well is shut down so that there will be gas to start up with. After the unit is started, the valve on the top of the flow line is cracked sufficiently to allow all of the gas and part of the crude to pass through, the gas going to the fuel system and the oil back into the well.

Tank Mounted on Truck Has Many Field Uses

A rectangular, 75-80 gallon tank mounted on top of the cab of a pickup truck can perform many jobs in the oil fields. To facilitate handling either lubricants or engine fuels, a regular service station hose and fill nozzle can be added and the nozzle hung on the back side of the tank as shown. Since the hose is made for gasoline, it is not harmed by lubricating or fuel oil.

The tank may be fabricated in the welding shop of thin plate steel. To eliminate movement of fluids, it is advisable to add compartments in the tank before adding the top. The mounting rack is bolted to the tank by means of strap steel bands that hold it securely at each end. The mounting rack can be fastened to the truck top by bolts, or, preferably, by welding. If bolts are used, a gasket must be applied between the rack footing and the cab top to prevent leaks.



Tank atop truck

The addition of lubricants to small engines is an easy task as well as a clean one when such a tank is used. Fuel tanks of diesel engines can be filled in short order. By placing the tank on top of the truck cab, floor space in the truck bed is not taken up, and, therefore, more space is available for transporting other items.

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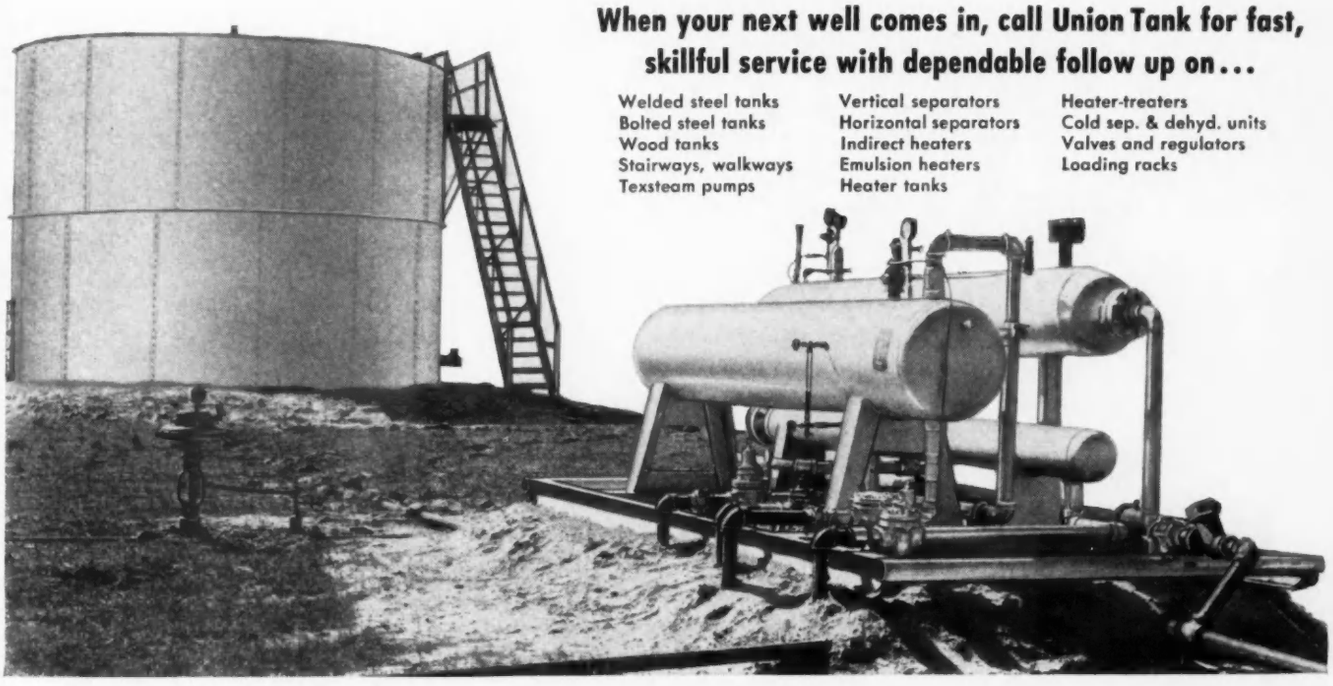

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A miniature pile driver made in the shop from salvaged parts saved considerable labor in driving fence posts on a lease in Oklahoma. It was light enough to be handled by two men. Power to lift the weight was supplied by the winch of a boom truck. Although originally built to stake up a gas line, it has proven a handy gadget on many a field construction job where pile driving was needed. The hammer proper is a section of six-inch pipe poured full of metal, with vertical fins welded to the opposite sides. The fins fit loosely in the guides of the upright frame to permit the hammer's free fall. A bail at the top of the hammer, a pulley at the top of the upright, a pulley on the flat frame (directing the rope to the truck's winch at about 90 degrees), the truck's power winch and a tug from the man on the truck bed hoist the pile driver easily.

When the rope is released by the man on the truck-bed the hammer falls, striking the free-sliding cap (set in the guides of the upright like the hammer) which fits over the scrap-pipe piles, imparting the blow of the hammer to the pile without splitting it.

Concrete Runners Provide All-Weather Approach

In low marshy country the servicing of wells has always presented the problem of setting up the pulling machine to give it maximum stability on short order. This has generally meant the constructing of a board road or ramp at the well site to accommodate the cumbersome machine. In addition to this, when the service work is completed, there is always the mess to clean up and broken boards to remove from the location.

One lease foreman solved this problem with a minimum of expense by digging two furrows from the lightly shelled road to the wellhead. These

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The Hercules "Type E" (for Economy) Casing Head was designed as an economical means of supporting and packing-off casing strings in wells of medium depth and pressure. It is made of electric cast steel and is tested to 3,000 pounds psi. It will safely support in excess of 50 tons of casing with a 2-to-1 safety factor.

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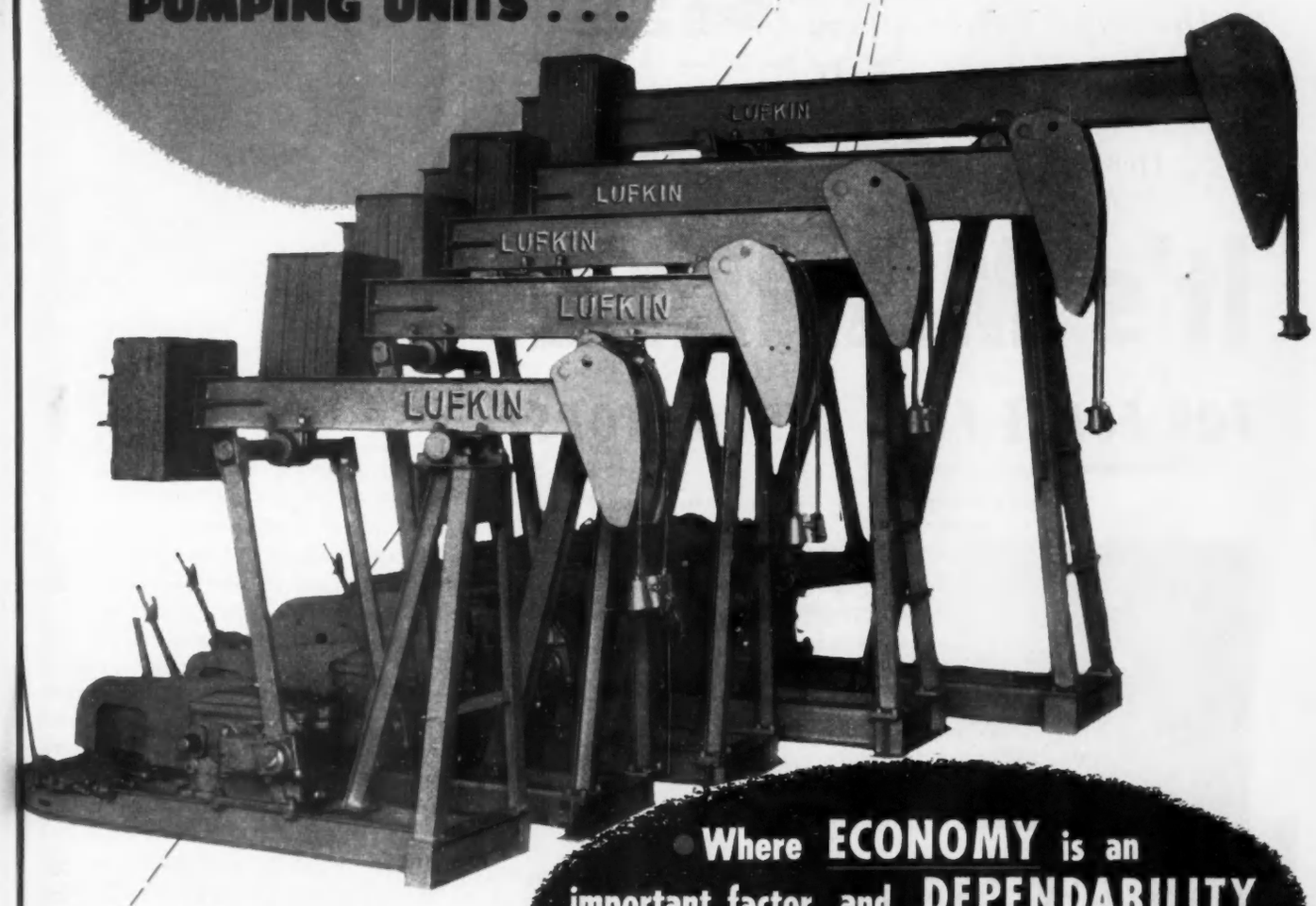

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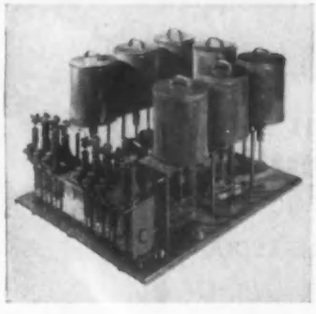

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HINTS . . .

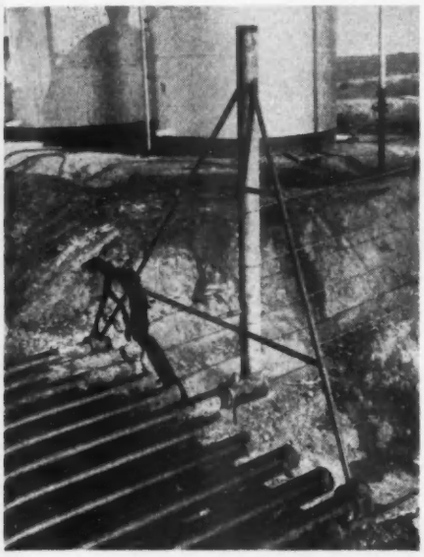
furrows were spaced far enough apart to accommodate the wheels of the pulling machine and those of trucks that made routine trips to the site. The furrows were lightly reinforced with scrap re-bar, pipe and odds from the scrap pile.

Mixed concrete was poured into these furrows, forming two runners six inches thick. The runners were connected at the well end by a concrete apron poured from this same mix. The completed job presented a neat appearance, provided an efficient way to set up pulling machines and gin poles and provided an all-weather approach for pumper's trucks and other vehicles.

Cattle Guard Made With Removable Ends

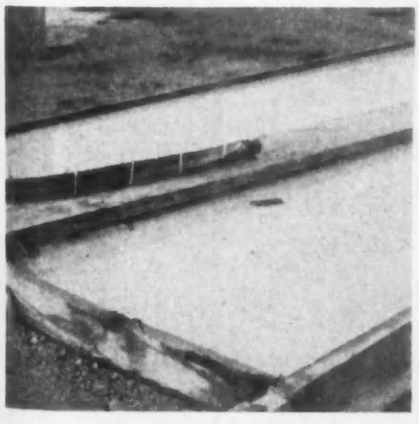
On leases where the expected production life is short or where the well being drilled may be a dry hole and it becomes necessary to move the cattle guard, a simple attachment may be used to disconnect the side pieces of the cattle guard from the main railings for easier transporting and relocation.

The only change from the regular pipe-made cattle guard is to extend the center piece approximately one foot for the support of the main post. Make collars of the next larger size of pipe to fit over the ends of the side railings and the aforementioned center railing. Weld the center post



securely to the one end of the center collar and use sucker rod material for braces on the sides of the end pieces running to a point near the top of the post as shown. Weld two cross pieces across the braces to further strengthen them and make the cattle guard more effective.

Matching holes are burned through the three collars and pins inserted to hold the collars in place. Stretch the wire on the posts and the cattle guard is in operation. When it is necessary to move it, untie the wire, pull the three pins on each end of the guard, remove the pieces and lay them flat on the guard, ready for storage or erection at a new location.



Rubber Hose and Plank Disperse Fluids in Pit

Here is a temporary but inexpensive way to disperse fluids that are dumped into a settling pit. Idea is to add the fluids without stirring up the contents already in the pit, thereby

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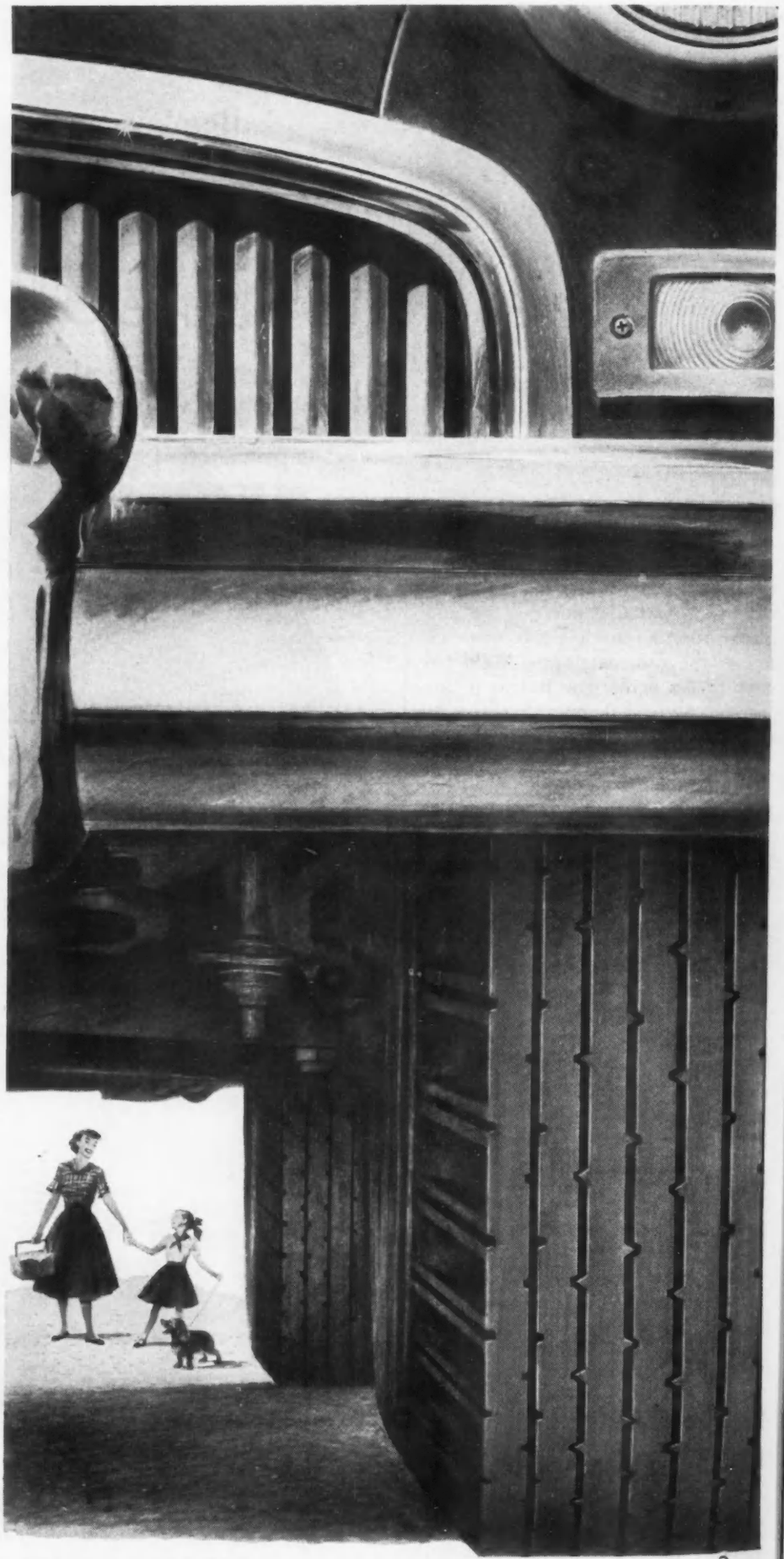
Our 125 "dry holes" last year helped keep you on wheels

If you're anything like the average motorist, you'll need about 690 gallons of gasoline to take you where you want to drive this year. And that's just a beginning. Keeping you on wheels and supplying you with the thousand and one "oil-born" products so vital to modern living requires 2 gallons of petroleum a day for every man, woman and child in the U.S. — an increase of 58% since 1941.

Helping to keep this oil flowing to you is Standard Oil Company of California's biggest, most expensive, least predictable job. In fact, we plan to invest $200 million during 1955 alone in exploring for new oil fields and developing existing ones, to help replace the petroleum you'll use.

Some 700 times during the year, Standard drillers will start bits spinning. As much as 16,000 feet of pipe may follow the bit before oil is found or the well is abandoned. Either way it's a costly hole: drilling an oil well may run anywhere from $125,000 to over $1 million. And every one is a risk—only 1 out of every 9 wells drilled in the United States in a promising but unproven area ever turns out to be an oil producer.

Yet new sources of oil must be found to keep our nation's abundant supplies from dwindling. Risking "dry holes" is the only way to find them. So the 125 "dry holes" we drilled last year are good evidence of the job Standard does to help keep you on wheels.



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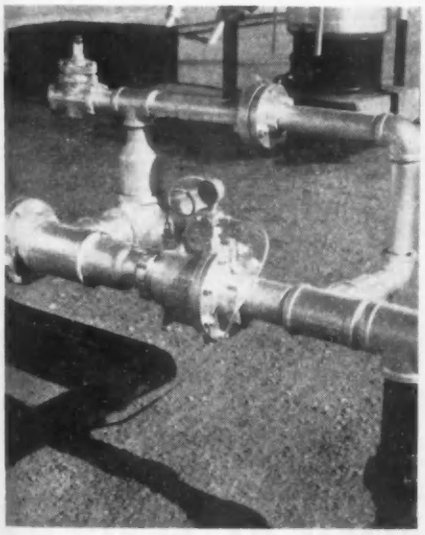
not interferring with the settling process.

In this case, the pit was made from timber and was not very large. Thus, the need for decreasing agitation was even greater. To be able to add fluids, yet spread them over the widest possible area to reduce agitation, a 3 x 8-inch plank was supported at the high-water mark and down the center of the pit. The other end was braced to the edge of the wooden pit.

A rubber hose, through which the fluids were discharged, was placed down the center of this wooden plant. Parallel rows of large nails on either side of the hose held it on the plank. The length of board left beyond the discharge of the hose was sufficient to allow the fluids to be distributed widely over the pit.



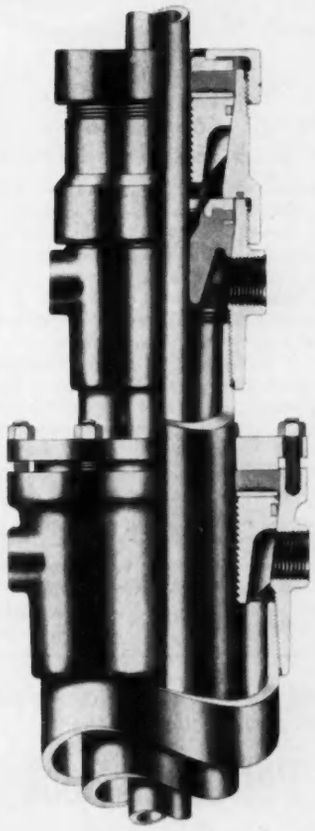
Burst Plate Protects High-Pressure Separator

A high-pressure separator of a two-stage separation system was protected from extremely high pressure by means of a bursting plate assembly. The bursting plate line bypassed a back-pressure regulator.

The high-pressure separator operated at about 150 pounds per square inch pressure. This gas was fed into a gathering line for injection back into the reservoir. However, should the flow line regulation equipment fail for any reason and higher pressures be exerted on the separator, the bursting plate would fail at about 185 pounds pressure so that much of the high-pressure gas would bypass the regulator and flow into the distribution line which is capable of withstanding the higher pressures.

RECTOR TYPE "R"
Low Pressure, Low Price, FORGED STEEL
CASING and TUBING HEADS

GIVE YOU MAXIMUM VALUE IN EVERY RESPECT



• Designed for pressures up to 2,000 lbs., Type "R" Casing and Tubing Heads have many features and advantages that make them outstanding values in heads of this type. Extremely adaptable, they are ideally suited for the widest possible range of producing conditions. Ask your Rector Representative or SUPPLY STORE about Type "R" Casing and Tubing Heads for your low-pressure wells, or to replace high-pressure tubing head and tree when changing from flowing to pumping conditions.

SEAL
Both casing and tubing heads have an oil-resistant pack-off which is forced into sealing position by a split packing gland. Casing Head gland is tightened down by 6 stud bolts . . . Tubing Head gland by a cap threaded to the body.

SUSPENSION
Casing Head has case-hardened, three-segment type HINGED slips of ribbed construction to allow full flow to outlets. Tubing Heads employ same type of suspension or special threaded type or slip-type mandrel hanger for use with Kobe pump.

SIDE OUTLETS
Both Casing and Tubing Heads are available with 2", 2½" or 3" threaded side outlets.

BOTTOM CONNECTIONS - SIZES
Casing Heads have male or female threaded bottom connection sizes 8⅝" through 13⅜". Tubing Heads available with male or female threaded bottom, 5½" through 7", also all flange sizes and series, with standard API ring groove and bolting arrangement.

STRIPPER
When desired, a slip bowl adaptor carrying slips, packing and gland can be attached to the threaded top of tubing head body. Strippers and slips are interchangeable.

For complete description and illustrations of various assemblies, see pages 4230-34 of 1954-55 Composite Catalog.

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RECTORHEAD RECTOR GULBORD METHOD RECTORSEAL

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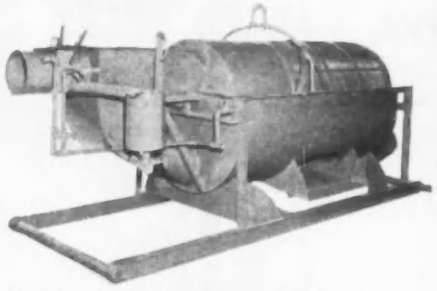

Linda "K" Sample Catcher Is Fully Field Tested and Proven

Washed cuttings of the finest sand can be taken continuously, or at any desired interval by the new Linda "K" Sample Catcher. Fully field tested and proven, the Sample Catcher is now available for installation on Linda "K" Rotary Shale Extractors.

A removable Catcher screen is enclosed in the charged cylinder and is sprayed by jetted water from the inside wall of the charged cylinder, which prevents overflow of the screen and gives a true washed sample of the cuttings. Washing fluid can then be returned to mud system or waste pit.

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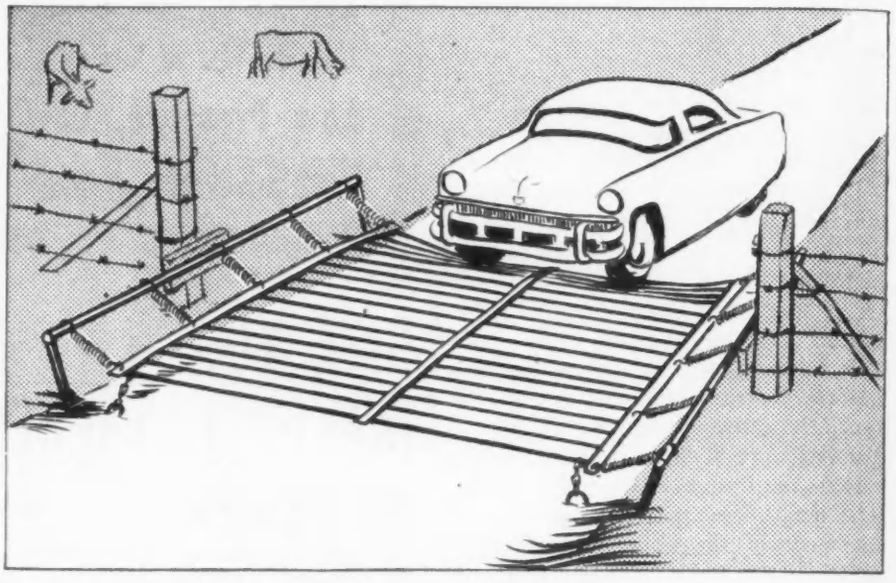

Coil Springs Support Cattle Guard

This unique type cattle guard can be used effectively without the need of digging a ditch in which to set the conventional type guard. Instead, this "bed-spring" cattle guard is supported about six or eight inches off the road bed by ten coil springs measuring about 12 inches long. They are fastened to an anchor pipe which, in turn, is supported by the end fence posts.

The guard is merely a grill work of sucker rods welded to tubing at each end. A center pipe adds strength to this grill work of rods. At the four corners of the cattle guard are anchors, large U sections of sucker rod material which have been driven into the road bed, or set in concrete. Corners of the grill are stabilized by fastening short lengths of chain to the anchor and the grill.

In its normal position above the road bed, the guard prevents cattle from passing through the fence opening. When a car or truck passes over it, the springs let the grill press flat on the road bed until the vehicle is off the grill. This type unit is inexpensive, and its biggest feature is that a large ditch is not necessary.

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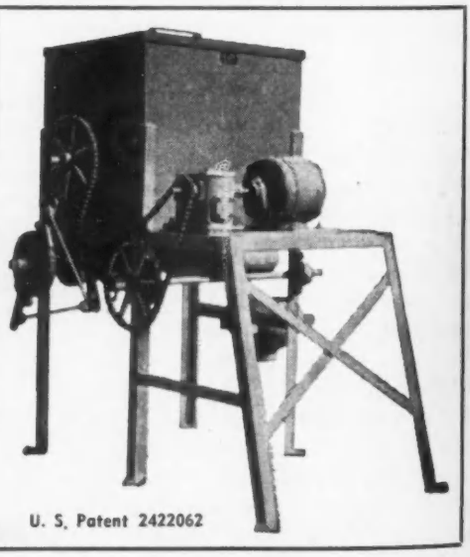
the dependable, economical water treater

CHECK THESE FEATURES:

- **Used in Oil Well Water Flooding, Municipal Water Treating Plants, Canneries, etc.**
- **Can be driven by water entering plant for treatment.**
- **Maintains pre-set water-chemical ratio through a wide rate-of-flow range.**
- **Adjustable two ways, to feed from a few pounds to several hundred pounds of chemicals per day.**
- **Also can be equipped with electric motor, or gas engine drive.**
- **Made to your specifications in various sizes.**
- **In use the world over.**

Whatever your water treating problems may be, investigate the Western Feeder. Write for literature and prices.

For complete description see Page 2630 of the Composite Catalog.



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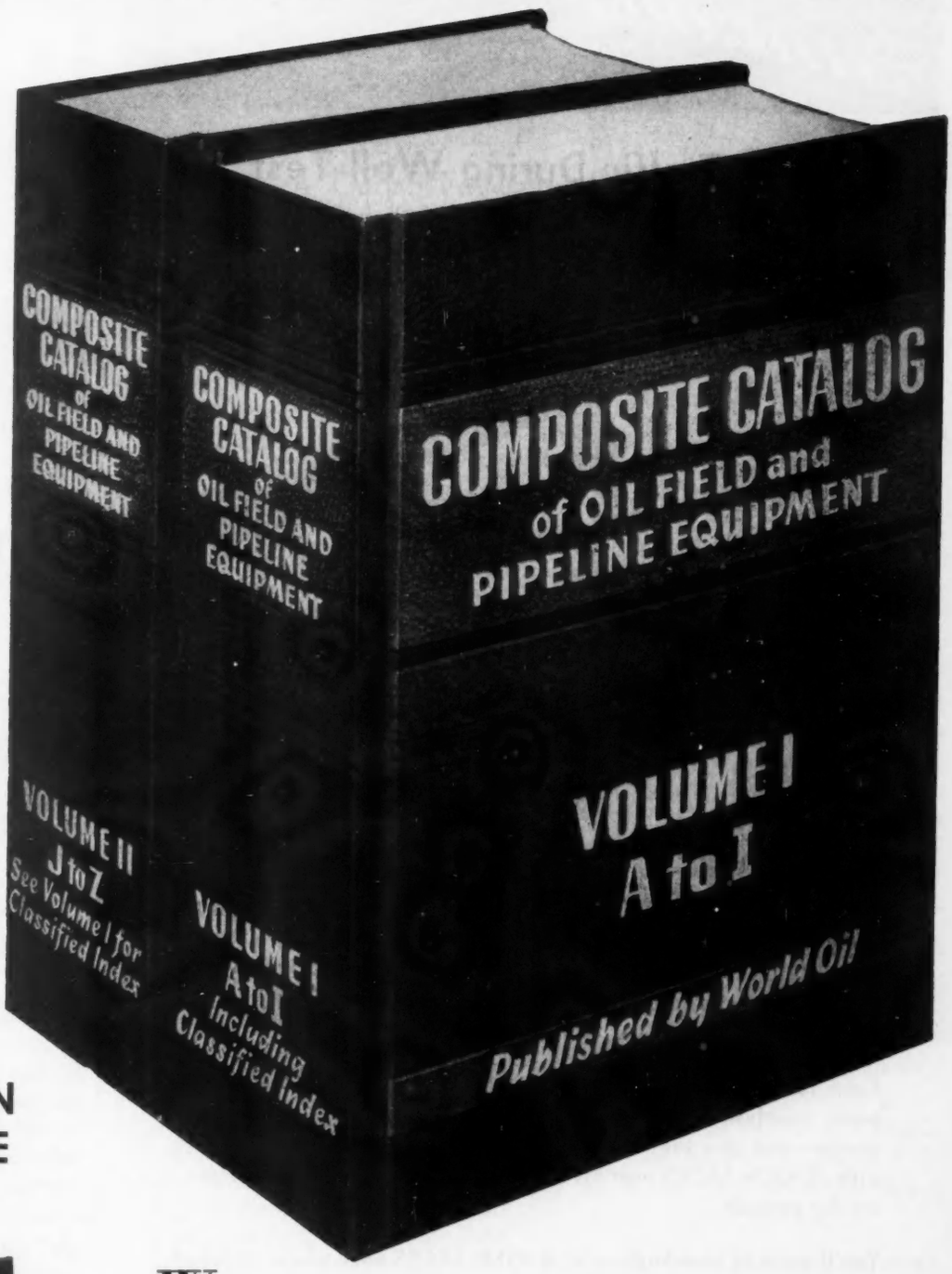
COMPOSITE CATALOG of OIL FIELD AND PIPELINE EQUIPMENT
COMPOSITE CATALOG of OIL FIELD AND PIPELINE EQUIPMENT
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VOLUME II J to Z See Volume I for Classified Index
VOLUME I A to I Including Classified Index
VOLUME I A to I
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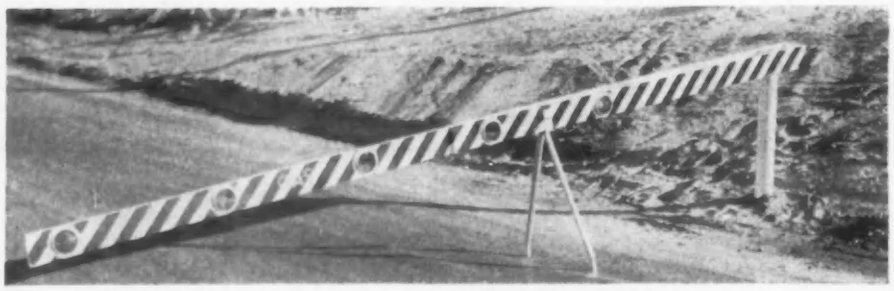

Gate Halts Traffic During Well Test

During the critical hours when gas may escape from a formation test or flow test of a high-pressure, light-gravity well, swing an inexpensive gate across the roadway to close off nearby lease roads and keep unauthorized persons at a safe distance.

Pivot the gate on a single pipe post set up on the edge of the road and use a light weight pipe A-frame about one-third the distance from the pivot to the end of the gate to support it. Paint the gate with diagonal stripes and add five red reflectors so it can be seen from a distance.

Such a gate can easily be swung out by one man during the critical period when fire hazard is greatest.

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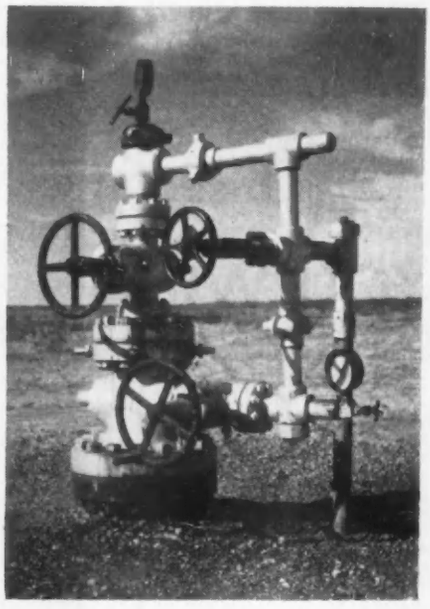
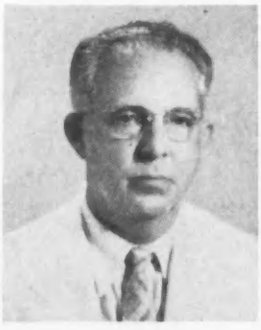


Adjustable Choke Handles Dual Flow

Flow from this well either through the casing annulus or the tubing may be controlled by one adjustable choke on the flow line. Each flow wing ties into the adjustable choke cross fitting as shown. The choke body is in the form of a tee, with the discharge located opposite the adjustable choke stem and wheel. All lines are two-inch, and valves on both the tubing and the casing line permit full closing or opening as desired.

With this type hookup, flow can be controlled from either the casing or the tubing through one flow line to the tank battery. Number of fittings and pipe work is minimized, and the arrangement provides flexibility of operation. Bull plugs in the tees on the flow line from the tubing and casing wing permit tests to be made or samples to be taken as desired.

a WORLD OIL interview



with Ing. Antonio Calvache
Director of Forests, Mines and Wildlife
Ministry of Agriculture
Republic of Cuba

What Cuba Is Doing To Aid Oil Operations

A Cuban government official points out the steps taken by his country to establish a favorable climate in which both domestic and foreign oil operators can conduct their activities.

By **J. E. KASTROP,** WORLD OIL Staff

Q. *What, generally, is the government's attitude toward oil development in Cuba?*

A. The attitude of the Cuban government is reflected in its many activities designed to stimulate petroleum exploration in the National Territory. It has facilitated securing concessions, reduced the superficial tax (rentals) by one-third (now amounts to about 2 cents per acre per year) during the five-year period (from 1954-1959), granted exceptions to taxes on importation of drilling and exploration equipment, and made tax exemptions on capital investments used for study and work during the same five-year period.

Q. *How does the government feel about recent oil discoveries and current oil exploration activity in Cuba?*

A. The government of Cuba has followed attentively geological studies and exploration carried on for some years by great North American oil enterprises. It has taken advantage of the circumstances surrounding the discovery of oil at Jatibonico by a group of spirited Cubans to dictate the measures outlined above in favor of the search and production of petroleum. This has been done with the assurance that it will result in a multiplication of the number of wells that will be drilled in those basins considered geologically as containing potential petroleum structures in our country. It will also extend investigations to other areas not yet explored.

At this writing, about six months after publication of the law or decree of stimulation containing the means outlined in answer to the first question, there are now seven more wells in Jatibonico, five of which are productive. In another field, Bacuranao, three wells have been drilled, two of which are good producers. At this time there are seven rotary rigs in operation and 14 cable tool rigs active in other parts of the island.

Q. *What is the government's attitude toward companies and individuals outside Cuba that are interested in participating in Cuba's oil development?*

A. The mining laws of Cuba are applied equally, in right and obligation, to Cubans and foreigners alike, with only one condition: that they do not belong nor do they participate in activities of groups or countries that are anti-democratic. Under these conditions, our government receives in a worthy attitude all companies and individuals from foreign countries who may come to participate in the development of oil in Cuba.

Q. *Cuba's Mineral Fuel Law of 1938, as formerly discussed in* WORLD OIL *in October, 1949, and reviewed again in May, 1950, has been extremely helpful in attracting private capital into the development of oil in Cuba. Has this law been modified or changed? If so, would you summarize these changes or modifications?*

A. The law of Combustible Minerals that has been in effect in Cuba since 1938 has not been changed basically. Except to produce a stimulation in interest in exploration and production of petroleum, they have been modified for a period of five years, ending July, 1959, to include the following precepts of the law of 1938:

1. All those sections attached to the National Reserve through

Continued on Page 292

HELICOPTER LANDED on Shell's new medium duty drilling barge while it was still in builder's yards in The Netherlands.

Barges Built in Netherlands For Use in Lake Maracaibo

Shell of Venezuela receives first of two new medium-duty drilling barges. It is designed for addition of DC electrical equipment if needed.

COMPANIA SHELL DE VENEZUELA, LTD., has received the first of two new tender type drilling barges for use in its operations on Western Venezuela's Lake Maracaibo. The new barges are in the medium duty class and are of similar general layout and dimensions to a heavy duty vessel that has been used on the lake. This barge was built in The Netherlands. The second is under construction.

These barges will operate in association with permanent drilling platforms in accordance with Shell's standard practice on Lake Maracaibo. These 24 by 49-foot double cantilever platforms are mounted on 24-foot square steel pile template type foundations that can be set in water up to 120 feet deep and which are arranged to accommodate conventional derricks together with hoisting machinery and the usual items of derrick floor auxiliary equipment.

The medium duty class barges are 158 feet long and 80 feet wide with a draft of eight feet and a total displacement of 2715 tons. Less elaborate in design than the heavy duty vessel used by the company, the barges have diesel powered mechanical drives rather than diesel-electric powered drilling machinery on the older vessel. A unique feature of the new design allows for the later addition of direct current electrical equipment should future requirements call for hoisting power at the drawworks in excess of that available from the straight mechanical drive.

A three deck arrangement is employed comprising main, pump and pipe decks. In addition, a helicopter landing platform is provided in the form of an elevated floor aft of, and

STARTING LONG TOW from The Netherlands to Venezuela and duty in Lake Marcaibo.

Shell Photos

approximately eight feet above the upper, or pipe deck. The flat-bottomed, all-welded hull is divided into 29 main water-tight compartments.

The main deck is continuous except in way of the slush pump room and is arranged to accommodate the main and auxiliary power equipment, mud handling facilities, store rooms, crew's quarters and anchor winches and associated marine equipment. Situated at the bow on the hull centerline is a raised platform for a dual mud screen assembly, flanked on the starboard side by a sand settling pit which incorporates a hydraulic/pneumatic dumping valve for discharge of sand and other sediment through the bottom of the hull.

Similar, but valveless, openings are provided at the mud screens so that formation cuttings can pass direct through the barge bottom without fouling the deck. A small core lab, furnished with means of carrying out core, ditch sample and mud test on site is located near the mud screen mountings and is adjacent to mud chemical treating facilities.

The lower deck holds the seatings for the three main slush pumps. This deck also accommodates centrifugal mud transfer pumps and ballast, bilge and rig water supply pumps, arranged in pairs. Space is also provided for a single crude oil transfer pump. Open mud suction tanks are located at each side of the centerline and extend from the double bottom of the barge to the main deck.

The mud storage tanks extend from behind to port and starboard of the suction tanks to form two ell-shaped enclosures which allow easy connection to the main slush and transfer pump manifolding.

The upper deck serves mainly as a pipe rack and also as a working deck for the preparation of tools and material prior to running these in the hole. There are two crane mountings, one on each side of the pipe rack. Extending across the engine house roof on this deck is a semi-enclosed space in which deck houses for supervisory staff are provided.

These buildings include a small galley, limited sleeping accommodations, radio room and wash rooms. The helicopter landing platform of about 3200 square feet is located above the supervisory staff houses.

The drilling power on the barge consists of four standard oilfield diesel engines, each developing 400 horsepower. Remote air controls enable operation of the engine throttle, slid-in scoop fluid couplings and pump clutches from a station in the pump room. The two main and one stand-by slush pumps each have a rated working pressure of fluid cylinders of 3500 pounds per square inch and input rating of each power end is 670 horsepower at 80 strokes per minute.

The barges will be used in association with drilling platforms in the lake which have independent, derrick-floor mounted, diesel-powered draw-works with a six-speed transmission connected to the power unit through a fluid coupling. —**The End**

TAKING THE CLASSROOM TO THE STUDENT. With operations of Socony-Vacuum of Venezuela spread over a large area of the country, it was impractical to transport groups of employes long distances for one-hour training conferences. The company decided to take classroom to the employe and redesigned a large trailer bus for this purpose.

2-Way Training Paves Way For Venezuela Operations

Socony-Vacuum of Venezuela teaches Spanish to expatriates and develops Venezuelans to provide highly-skilled employes.

By A. R. TAYLOR, General Management Assistant,
Socony-Vacuum Oil Company of Venezuela, Caracas

TRAINING AND DEVELOPMENT of oil company personnel abroad require use of basic programs familiar to U. S. companies plus the need for special training programs to meet specific conditions. In a previous article (WORLD OIL, August 1, 1954, Page 204), the organization and manpower planning, development and control functions of Socony-Vacuum Oil Company of Venezuela were discussed. This article describes three specific training programs used by the company: Language training, vocational training and educational scholarships. A later article will discuss some unusual aspects of the company's safety program.

Language training was considered essential for expatriate personnel of Socony-Vacuum of Venezuela before scheduling these employes for other types of training programs necessary for their advancement in the company. In the U. S., management has come to recognize that even where one language is used there are serious communications problems, both horizontally and vertically, in an organization. In foreign operations, these problems are seriously aggravated by the existence of two or more languages and different cultural backgrounds. These additional barriers have to be overcome, at least to some degree, before effective personnel development and training can be accomplished.

There are other complicating factors in a language training program in an oil producing operation, such as the differences in age and educational background of the students, the large areas over which supervisory personnel are spread, and the constant changes that take place in their work schedules.

A survey by the company of language training courses and methods revealed a wide divergence of opinion, ranging from the view that by simply exposing a man to a foreign language he would learn it, to the opinion that special schools should be set up for the purpose. Socony-Vacuum of Venezuela decided on the latter. A first step was to establish four levels of language proficiency, ranging from ability to communicate verbally, to a good command of the written and spoken forms of the language. Each department head was asked to indicate on the Job Description for every monthly payroll position in his department the language level required for that position.

Teaching techniques. Language proficiency tests were developed and monthly payroll employes were tested to determine the relationship between their language ability and the standard required for the job that they held. Courses were developed for those who could not meet the required standard, and flexible class schedules were arranged.

It became apparent from the beginning that language training is not a subject that can be dealt with adequately by a layman. There was, and still is, need for a great deal of research in course materials, teaching techniques and language aptitude and proficiency tests. During the first three years of this program, the services of a consultant were employed, followed by the full-time employment of a former member of the staff of Cornell University.

It now requires from 250 to 700

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SPANISH INSTRUCTOR KANEE conducts a class. Second from right is W. B. Colvin, division management assistant of Socony-Vacuum of Venezuela and former drilling editor of WORLD OIL.

hours of classroom instruction to bring a North American employe to a point where he can communicate effectively in Spanish on the job. Although the training supervisor in charge of language instruction is constantly investigating and developing new applications of language teaching methods and refining course materials in accordance with specific job requirements, it has become obvious that an equally important factor is the attitude of the student toward language learning.

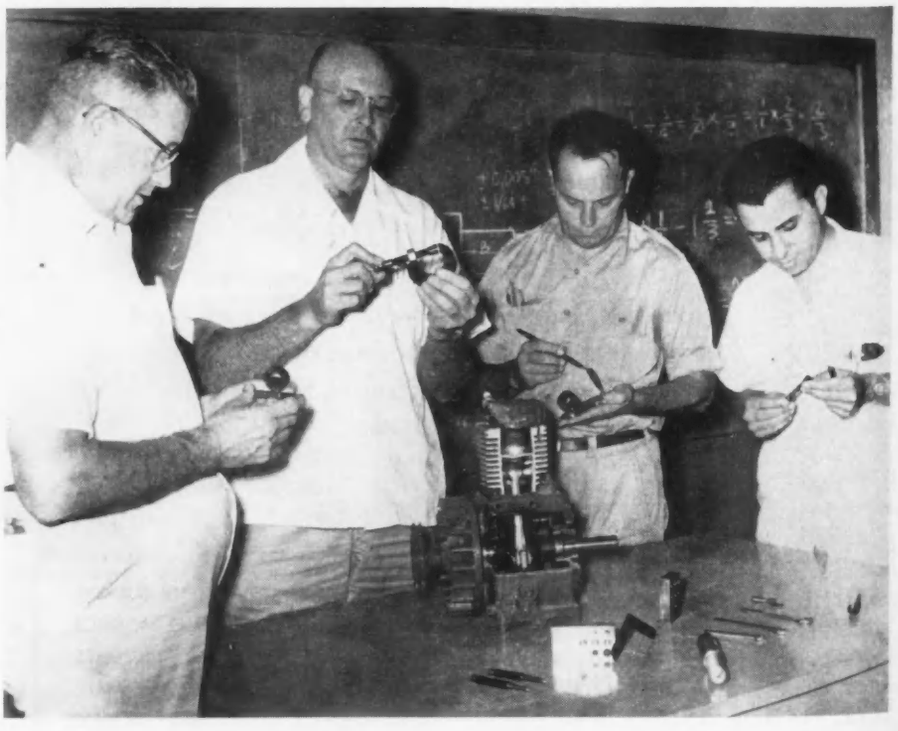
Some steps have been taken to bring about the desired attitude. Perhaps the most important is that top management has made it clear that each expatriate employe is expected to reach the proficiency level required for his job within a reasonable period. In fact, the form used for processing increases in salary and promotions contains a section in which language proficiency is recorded. Although this does not determine finally whether salary increases or promotions will be approved, it has a marked influence on the decision. Another important step is the practice of including in the appraisal of the expatriate's performance his ability to develop Venezuelan nationals into key positions. To do this, he must be able to communicate in Spanish.

The company's language training program is directed at the middle and upper levels of the company, but Socony-Vacuum of Venezuela has also placed an important emphasis on the training of skilled labor, essential to the effective operation of the company.

Vocational training activities are under the direction of a former member of the staff of Purdue University. The program is divided into two divisions, both of which are staffed entirely by Venezuelan nationals. These consist of the Industrial Training Center, and the on-the-job training program.

Industrial Training Center has, as one of its main functions, a program to give young Venezuelans of high school age a three-year trade training course to supply future skilled labor requirements. Periodically, all employes and nearby schools are advised that Socony of Venezuela will award 15 scholarships to young Venezuelans. The applicants are screened with the aid of a battery of 20 tests and a structured interview. The successful candidates are given a six months' scholarship, renewable every six months for a period of three years, which entitles them to company housing and a regular monthly income.

On-the-job training. The first six months of the Training Center course is in the shops and classrooms where students are taught the elements of oil field trades and attend classes in mathematics, elementary physics and chemistry, mechanical drawing, blueprint reading, health, safety, and sanitation. At the end of this period, a



INDUSTRIAL TRAINING CENTER students' work is inspected by C. Callihan, mechanical and electrical engineering supervisor; Clark Gruver, operations superintendent; Kenneth Parr, vocational training supervisor; and E. Rojas, Training Center director.

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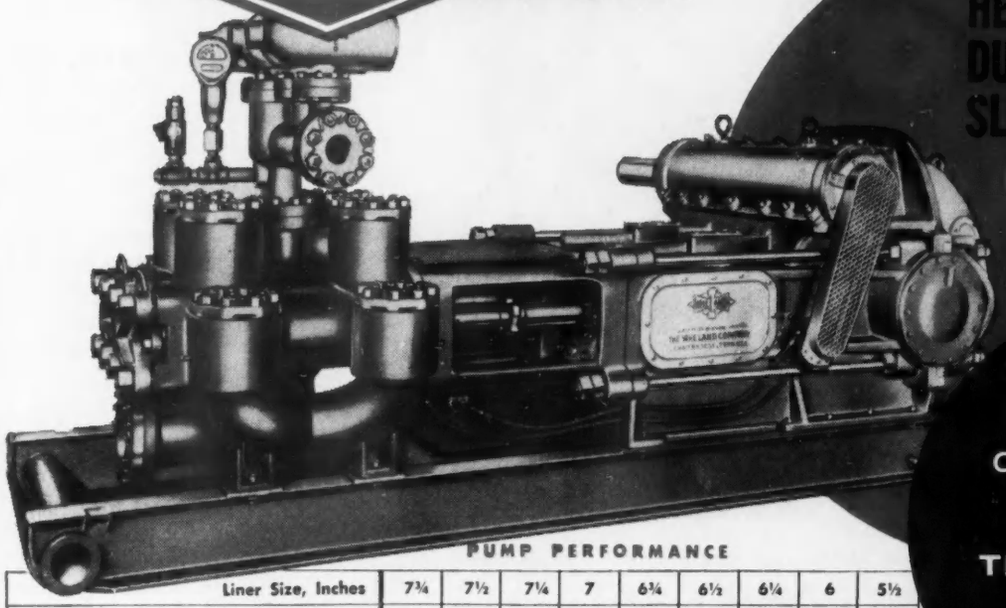

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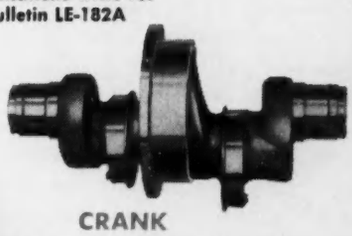
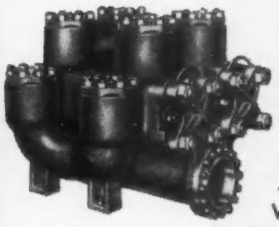
PUMP PERFORMANCE

Liner Size, Inches			7¾	7½	7¼	7	6¾	6½	6¼	6	5½
Maximum Discharge Gauge Pressure, PSI			1322	1419	1526	1648	1782	1937	2113	2314	2700
Speed of Crank RPM	Pump Horsepower Rating		Output in U. S. Gallons per Minute Pumped at 100% Volumetric Efficiency								
	Input	Output									
60	750	638	826	770	716	663	613	564	517	472	388
55	689	585	757	706	656	608	562	517	474	433	355
50	626	532	688	642	597	553	511	470	431	394	323
45	563	478	619	577	537	497	460	423	388	354	291
40	500	425	550	513	477	442	408	376	345	315	258
35	438	372	482	449	417	387	357	329	302	275	226
1			13.77	12.84	11.94	11.06	10.22	9.41	8.63	7.83	6.47

For complete details and specifications write for bulletin LE-182A



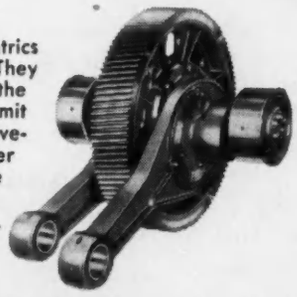


FLUID END

is a one-piece steel casting having one flanged suction opening, one studded discharge opening, eight separate valve pots with Wheland patented valve pot covers, Wheland back cylinder head and liner packing adjustment, tell-tale hole for liner packing, and screw type stuffing boxes fitted for circulating oil.

CRANK ASSEMBLY

Note the compact eccentrics integral with the crank. They increase the throw of the crank and permit the use of relatively small roller bearings in the connecting rod. Main gear, connecting rods and bearings are assembled on the crank with through bolts and elastic stop nuts.



CRANK

1 CRANK in One Piece.
2 Cast Alloy Steel Heat-treated.
3 Eccentrics integral with crank pins.
4 Seat for main gear tapered, keyseated and flanged for bolts through gear hub.
5 Throw is part crank, part eccentric.

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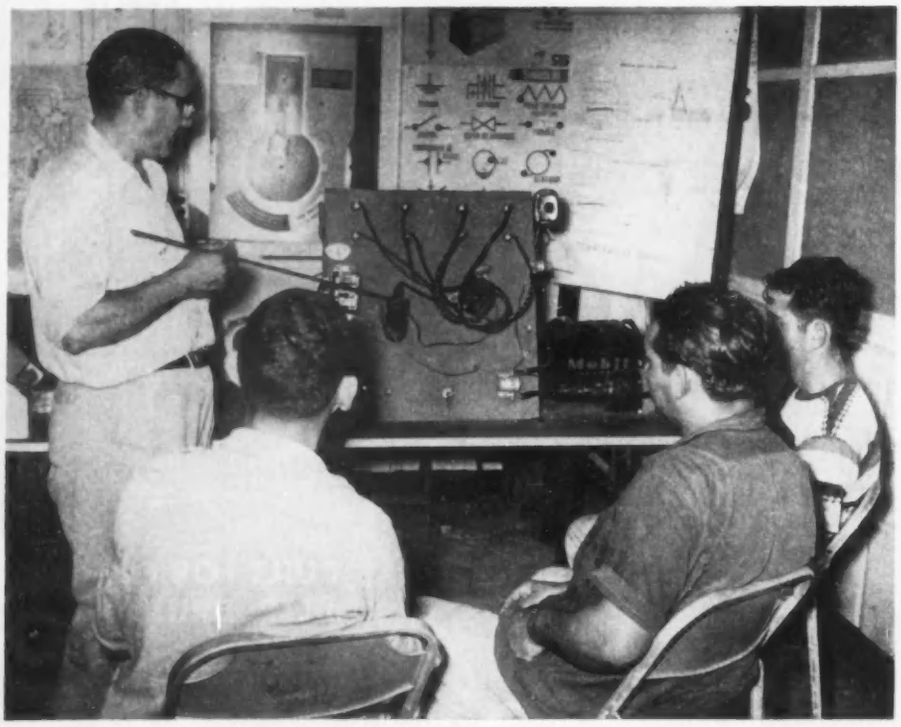

AN IGNITION SYSTEMS session is conducted by Training Assistant Jose Castro.

decision is made jointly by each student and the company on the trade in which each will specialize. The next 30 months are divided more or less equally between the classroom and working in the company's shops and field installations. During the second phase, each student works under a foreman and on-the-job contact is maintained by the Training Center staff and a Shop Training Committee. Special effort is made to provide facilities and guidance for extracurricular activities. Through this program, Socony-Vacuum of Venezuela hopes to meet its future highly skilled labor requirements.

In addition to the training available to scholarship students in the Industrial Training Center, an on-the-job vocational training program is offered by the company to its employes. A first step in establishing an on-the-job program for each employe is the preparation of the "Skills Inventory" chart as described in the August 1, 1954, issue of WORLD OIL (Page 205). This form has a breakdown of the desired skills across the top of the page, and employes' names are listed down the left side of the page. The degree of skill that has been achieved and the scheduling of needed training is shown opposite each name under the appropriate skill heading. Ideally, proficiency standards and proficiency tests for every classification of skilled labor should be used to aid in determining individual skills and training requirements, but their development, of course, is a long-range project.

Until recently, full time instructors were assigned to the training of drilling crews and automotive mechanics. From now on, the vocational training group will give more assistance to supervisors and foremen in training their own men. Where training problems arise that can be handled more efficiently through short courses, the vocational training group will prepare the course and in most cases present part of it in the Training Center and part on the job, with the assistance of the department concerned.

Other scholarships offered. In addition to the scholarships offered to the Industrial Training Center, Socony-Vacuum of Venezuela provides scholarships to qualified young Venezuelans at the university level which include living and tuition expenses. Each year, the company's scholarship committee arranges for company employes and local secondary schools to be informed that applications for these scholarships are invited.

In this program, too, a battery of test and structured interviews are used to aid in screening candidates. The problem here, however, is not so much one of selection as it is of finding candidates, because industry in Venezuela is expanding so rapidly that good students can pick and choose their future employers. For this reason, scholarships are also offered to students who have completed part of their secondary school work and who could not afford to continue without financial assistance.

The committee keeps in close touch with each of its scholarship students until he has graduated and those that become company employes receive further training for periods ranging from several months to a year and a half by the departments to which they are assigned. It is through this program that Socony-Vacuum of Venezuela hopes to fill an increasing number of its future professional positions with young Venezuelans whose higher education and training have been provided by the company.

At this point the question may well be asked, "Have all these activities paid dividends?" For years Socony-Vacuum of Venezuela and many other companies have searched for some concrete means of answering this question, but without very much success. Perhaps some of the current Operations Research techniques will help to provide an acceptable answer. Thus far, however, the most effective criterion has been the judgment of management and supervisors—the people who are actively putting these programs, or the result of them, to work.

—The End

About the Author

A. R. TAYLOR, general management assistant, Socony-Vacuum Oil Company of Venezuela, has had extensive experience in personnel development and employe training fields. He is largely responsible for the comprehensive program adopted by Socony-Vacuum of Venezuela for manpower development. A Toronto, Canada, native, Taylor spent three years as an apprentice engineer in Canada before joining Trinidad Leaseholds, Ltd., in Trinidad, B.W.I. He joined Socony-Vacuum of Venezuela in 1948 as safety and training director, being promoted to his present position in 1953.

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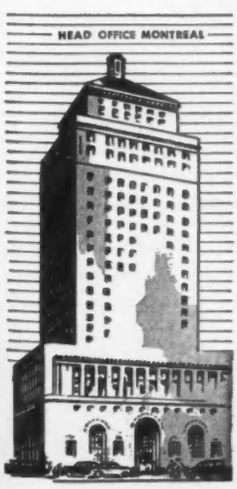

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What's Happening

AMONG WORLD OIL MEN

Standard-Vacuum Oil Company has announced appointment of E. W. (JACK) BERLIN as the company's general representative for its operating subsidiaries in Indonesia. Stationed at Djakarta, he will have administrative supervision over Stanvac's exploration, producing, refining, marine and pipe line transportation and sales activities in the Indonesian republic.

E. W. Berlin

He succeeds G. L. McCOY who, after a tour of Stanvac operating areas in Indo-China, Malaya, Thailand and other Far East countries, will return to the company's New York headquarters for reassignment.

Berlin, former manager of Stanvac's Producing department at the New York headquarters, and for the past year and a half special advisor to McCoy in Indonesia, has had 29 years in the petroleum industry, 26 of which have been in the international field.

Beginning as a land scout in the San Joaquin Valley in California in 1926, Berlin three years later went to Indonesia, where he helped develop the company's South Sumatra fields. He remained there until the outbreak of World War II.

During the war he served as a colonel in the Corps of Engineers, Petroleum Section, and later, in the office of the chief engineer, as area petroleum officer for the China-Burma-India theater.

After the war, Berlin joined Stanvac's New York staff in 1946 as assistant head of the Producing department, becoming manager the following year.

Active in the formation of the Defense Services Committee of the American Petroleum Institute, he was the committe's vice president from 1947 to 1949 and its president from 1949 until his return to Indonesia in 1952.

•

F. C. WHITESIDE, for the past five years an executive of Continental Pipe Line Company, Ponca City, Okla., has been appointed manager of pipe line operations and crude oil sales for Hudson's Bay Oil and Gas Company, with headquarters at Calgary. Both companies are affiliates of Continental Oil Company.

Whiteside joined Continental Pipe Line in 1950 as chief engineer, after service with other transmission firms. He held a succession of positions with the company before his promotion to manager of development and technical advisor to the president. He is a graduate of the University of Oklahoma at Norman.

•

JOHN W. PROCTOR, of Edmonton, Alberta, has been appointed executive secretary of the Alberta Division, Canadian Petroleum Association, and will make his headquarters in Calgary.

•

KENNETH H. WHITE, Ponca City, Okla., staff assistant in Continental Oil Company's Transportation department, has been promoted to traffic manager for Egyptian-American Oil Company, a subsidiary of Continental. He will continue to make his headquarters at Ponca City.

Egyptian-American Oil Company is exploring for oil in a 75,000-square-mile area in Egypt. In his new position, White will coordinate the movement of personnel, materials and equipment to the company's operations in Egypt.

A native of Newport, Neb., he joined Conoco's Transportation department at Ponca City in 1949 and was promoted to staff assistant in 1954. Previously he was associated for ten years with the Chicago, Burlington and Quincy Railroad Company at Omaha, Neb.

•

FATHOLLAH NAFISI, J. J. O'BRIEN, B. SCHEFFER, ABOL-GHASEM SHIVA and E. E. THORNELOE have been appointed to the board of directors of Iranian Oil Exploration & Producing Company, and DR. REZA FALLAH, MANUCHEHR FARMANFARMAIAN, M. HAGEN, D. C. HUSSEY and Thorneloe have been appointed to the board of directors of Iranian Oil Refining Company.

BRYAN L. DENSON, formerly general superintendent for American Independent Oil Company in the Neutral Zone between Kuwait and Saudi Arabia, has joined Egyptian-American Oil Company as drilling superintendent in Egypt.

Bryan L. Denson

Graduated from the University of Texas, Austin, in 1941 with a B.S. degree in petroleum engineering, Denson joined Magnolia Petroleum Company at Kermit, Texas, as petroleum engineer, and later took the same post with George P. Livermore at Lubbock, Texas. In 1945, he went to Saudi Arabia as resident engineer for Arabian American Oil Company.

In 1947 Denson returned to the U. S. and joined Drilling and Exploration Company at Bakersfield, Calif. The next year, he became petroleum engineer for Union Oil Company. Three years later he became division engineer.

•

DR. P. E. KENT, a senior geologist of The British Petroleum Company, has been awarded the Bigsby Medal by the Council of the British Geological Society "for contributions to the palaeogeography and stratigraphy of England and Wales, and his researches in Central Africa and Persia."

The Bigsby Metal was founded by Dr. J. J. Bigsby, a Canadian geologist who died in the last century. It was first awarded in 1877, and since then has been given every other year. It is intended as a recognition of past work, with a definite hope of more to come. A qualification is that the recipient must not be older than 45.

Dr. Kent joined British Petroleum in 1936, and has been closely associated with the company's drilling program in the United Kingdom. He has also seen service in Iran and East Africa, where a test well is now being drilled on Mafia Island, off the coast of Tanganyika.

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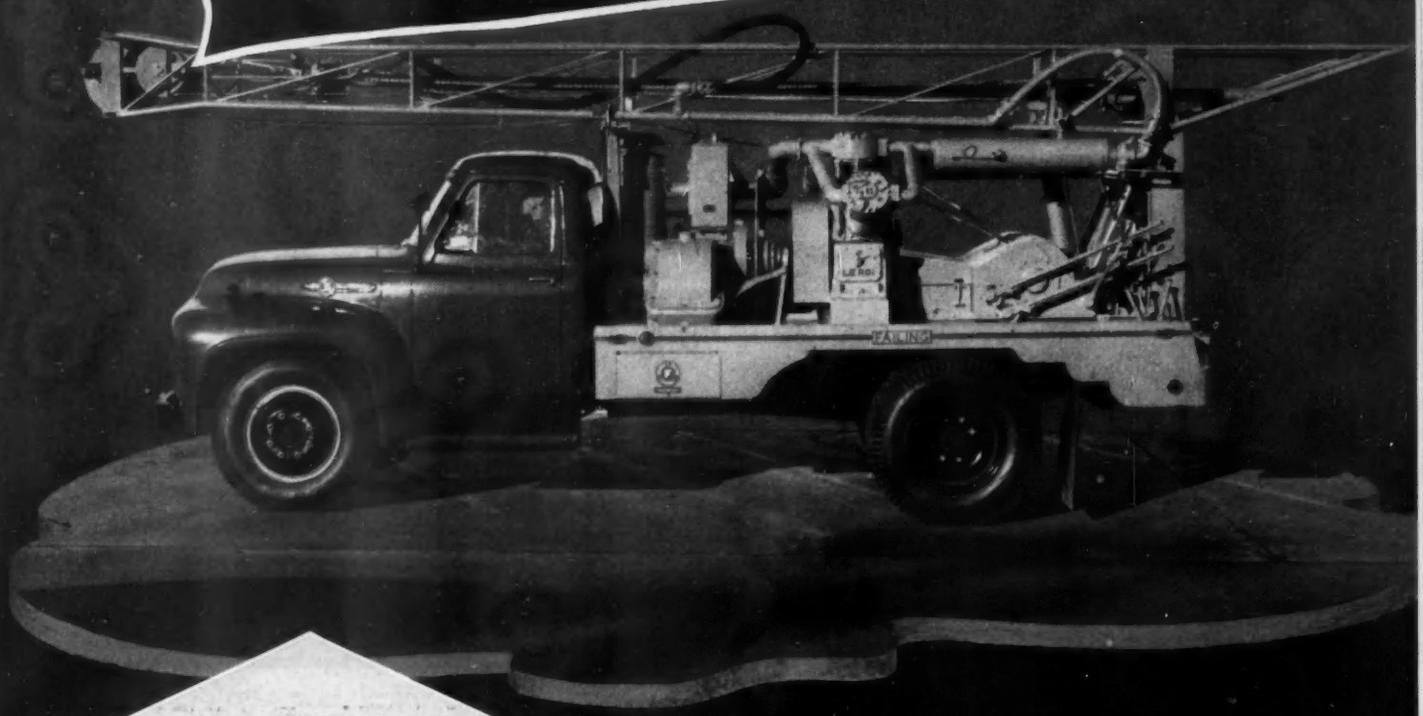

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This is one of the big reasons why oil men prefer to deal with independent distributors. They have enough problems on the rig during their daily tours, and enough headaches from meeting emergencies without having to worry about supplies. They know they can rely on their independent distributor to give them what they want, when and where they want it.

Here's why:

1. The independent knows the oil men he serves personally. He knows your problems and works along with you as a sort of friendly partner. Because of this, he is able to anticipate your requirements and have them on hand when needed.

For example, take the 19 independent distributors (listed at right), who handle Pittsburgh Seamless Oil Country Goods. If you need a string of drill pipe, casing or tubing, you can count on them to have it on hand when you need it and often on short notice.

2. When you buy from him, you know you are getting the best. Your independent selects his lines of equipment from a broad range of producers, so he is free to choose those suited for your requirements.

3. His service is fast and flexible. Your distributor makes a specialty of serving a small area well, rather than spreading out his efforts over the country. He offers 24-hour service on even the smallest items of equipment. He is on hand to meet emergencies.

What is equally important, he is able to make decisions and give you the right answers quickly because he is not bound by inflexible rules or remote control in handling your requirements. Often the store manager of one of the 141 stores of the independents listed, can handle supply problems directly that otherwise would mean red tape and delay.

4. You can be sure his price is right. Your independent works on low overhead and long experience. He is used to competition, and depends for his livelihood on being able to meet it. That's why independents are handling nearly 60 per cent of the equipment business in the oil fields today, compared to 15 per cent back in the twenties.

5. There is nothing impersonal about your independent distributor. He's a close friend of yours who has lived close by your operations for many long years, and keeps in constant touch. Because you know him, and he knows you, you can do business with him conveniently and with less paperwork. And remember this: The profit he makes from his business stays in your area.

6. In meeting your requirements, the independent distributor is backed by reputable producers with long experience and know-how in the manufacture of the equipment you use. He handles Pittsburgh Seamless, for example, because he knows Pittsburgh Steel Company has been producing for more than 50 years and has established a reputation for doing a good job.

Newly modernized and expanded mills have equipped Pittsburgh Steel to do a better job for you today than ever before, offering the same close personal service that has become the trademark of the independent. The next time you order seamless, why not get the pipe of your choice through the supplier of your choice? Always specify Pittsburgh Seamless!

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C. W. Cotton Supply Company
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Tulsa 5, Oklahoma

Franklin Supply Company
624 South Michigan Avenue
Chicago 5, Illinois

Houston Oil Field Material Co.
1524 Maury Street
Houston, Texas

Industrial Supply Company
500 Eighth Street
Wichita Falls, Texas

Iverson Supply Company
400 West Fifth Street
Tulsa, Oklahoma

Lucey Export Corporation
233 Broadway
New York 7, New York

Lucey Products Corporation
624 South Cheyenne
Tulsa 19, Oklahoma

McJunkin Corporation
P. O. Box 513
Charleston 22, West Virginia

Midland Supply Company
Box 3105
Washington St. Station
Wichita 7, Kansas

Mountain Iron & Supply Co.
100 Rule Building
Wichita 2, Kansas

Murray Brooks, Incorporated
P. O. Box 855
Lake Charles, Louisiana

Norvell Wilder Supply Company
P. O. Box 4145
Beaumont, Texas

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Oil Fields in Chile

Production, Completions And Footage Up in Chile

But congressional action awaited on new law which would open doors to private capital companies to bolster petroleum industry development.

By DR. J. E. RASSMUSS, Consulting Geologist, Lima, Peru

CHILE'S STATE-OWNED Empresa Petrolera Nacional is steadily developing the Magellan fields in the southernmost part of Chile, near Punta Arenas. Production increased last year by about 1,739,000 barrels, or 38 percent from the previous year. Also, the developed area has been further extended to the southeast by the discovery of the new Cullen and Flamenco pools.

In the Cullen pool, located east of the 1954-discovered Chilean pool, three wells have been brought in. In the continuation of this zone on the Argentina side of Tierra del Fuego, Argentina's oil agency, Yacimientos Petroliferos Fiscales, has drilled a well which reportedly is producing 600 barrels daily. In this area, the oilbearing Springhill sands are separated in three strata of a total thickness of 150 feet.

Empresa Nacional del Petroleo drilled 40 wells during 1954, 10 more than in the previous year, of which 14 yielded oil, four were gas producers and 22 were dry holes.

In addition to the important Cullen and Flamenco discoveries, smaller pools were found in Primavera, Victoria Este and Nandu. The Nandu discovery, located west of Flamenco, was the first gas discovery thus far.

Producing wells. Thirty-five wells were producing at year's end, and production during December amounted to 5950 barrels daily. Of the 162 wells drilled, including those last year, 67 have produced oil, 29 were gas producers and 66, or about 40 percent, were failures. Cumulative crude production amounts to 5.3 million barrels. Footage drilled during 1954 reached almost 288,700 feet, up more than 25 percent from the preceding year.

Trend of oil-bearing Springhill sands is northwest-southeast, crossing the boundary to the Argentina side. To the southwest, depth of the oil-bearing sands — which is approximately 7200-7600 feet in the developed field—increases. Farther south, south of Bahia Inutil, an exploratory test was drilled in Miraflores to 7168 feet, but was a dry hole.

On the continent to the west and northwest, exploratory wells drilled down to 10,000 feet have thus far remained in the Tertiary, not reaching the underlying Cretaceous beds which contain the pay zones on the island, and have produced only gas. Further exploration of the recognized structures and especially in the stronger folded belt to the west is planned for the future.

The refinery in Concon, north of Valparaiso, was scheduled to be inaugurated in February. The 20,000-barrel-a-day topping plant and the cracking plant already are in operation, and several shiploads of Middle East crude have been processed. Supply of domestic crude should cover about a third of the refinery's capacity.

The gas plant at Manantiales processes about 30 Mmcf of natural gas daily, yielding about 220 barrels of natural gasoline and 700 barrels of propane and butane a day. The 700-barrel-daily topping plant at Magellanes supplies products for the local regional use.

Private operations. Currently awaiting action by the Chilean Congress is the project submitted by the president to modify the established oil monopoly and to allow private companies to participate in the country's oil development. Reason for the project is the necessity of development

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- For the application, the constitution of a Chilean corporation is obligatory. No bearer shares are permitted for such corporation.
- Exploration concessions shall range up to 40,470 acres. After two years, one or two areas, not exceeding 10,117 acres each, shall be selected for drilling. A minimum of 32,800 feet shall be drilled in each of the selected areas over a five-year term. Thus, the exploration concession runs for seven years and, in certain cases, can be extended to ten years.
- If oil is discovered, a 30-year-maximum development contract for a maximum of 2023 acres in each drilling area may be negotiated.
- As royalty, at least 20 percent of the oil produced shall be delivered to Empresa at the embarking port free of charge.

This legal change, while not yet complete, does not indicate the number of exploration concessions which may be held by any one company.

Under the proposed law, the Magellan territory, where the only known oil deposits are, remains entirely reserved for Empresa. While few other oil deposits have been discovered in Chile, in the northern part of the country—in the Puna de Atacama of Antofagasta department—at an altitude of 13,000 feet oil seepages and asphalt outcrops are found in the Salar de Pedernales. They are related to igneous intrusions which pierce Mesozoic, presumably Cretaceous or Jurassic deposits.

Other seepages are found at Siglia, near the Argentina frontier, and bituminous shales at Pular, near the railway from Antofagasta to Salta. Widespread volcanic eruptions and lava sheets, the high elevation and unknown thickness and depth of the sedimentary beds in that region make the existence of commercial crude deposits highly problematical and recall similar occurrences in the high punas of Bolivia and southern Peru.

Little is known about the sedimentary character and thickness of the Mesozoic belt of northern Chile, farther south and east of the granite zone, except for the Jurassic porphyritic series.

Since immediate oil prospects, other than the Magellan territory, are unknown in Chile, a development of new crude reserves would, it is believed, be accelerated by opening the Magellanes province to private capital. —**The End**

Calvache Interview

Continued from Page 277

release, abandonment or lack of payment of surface tax, were made available to new applicants, thereby simplifying the paper work necessary for acquiring concessions on these areas by new applicants.

2. The superficial (or surface) tax was reduced from 15 centavos per hectare to five centavos per hectare (two cents per acre) per year.

3. Exemptions have been granted to the import tax for the admission of machinery and equipment into the country, and for the investment of capital for drilling.

4. Authority was granted to establish the national organization called "paraestatles" in order that with all the guarantees that were necessary, it can extend financial credit to those legally constituted enterprises to aid them economically in the acquisition of drilling equipment and in the expenses for geological and geophysical studies of potential petroleum areas.

Q. *In addition to an extremely liberal petroleum law, what other measures has the Cuban government taken to foster an active oil exploration program?*

A. In addition to the measures outlined above, our government intends to reorganize the Department of Mines of the Ministry of Agriculture and to give it sufficient authority to make quick disposition of applications for concessions. Also, the reorganization will enable the department to collect and publish the locations of both productive and dry fields that may be drilled, as well as data on the production of gases, naphtha and crude oil in the various fields.

Q. *What has been the effect of recent oil developments and activity on the economy of Cuba?*

A. I have already pointed out the good results obtained by the application of measures promulgated by our government to stimulate the search and production of crude oil in Cuba. But I should also point out two effects that benefit the public.

1. We have opened new phases of work for professional men and laborers. We have been able to interest a great number of families, merchants and industrialists in participating in the formation of oil exploration companies.

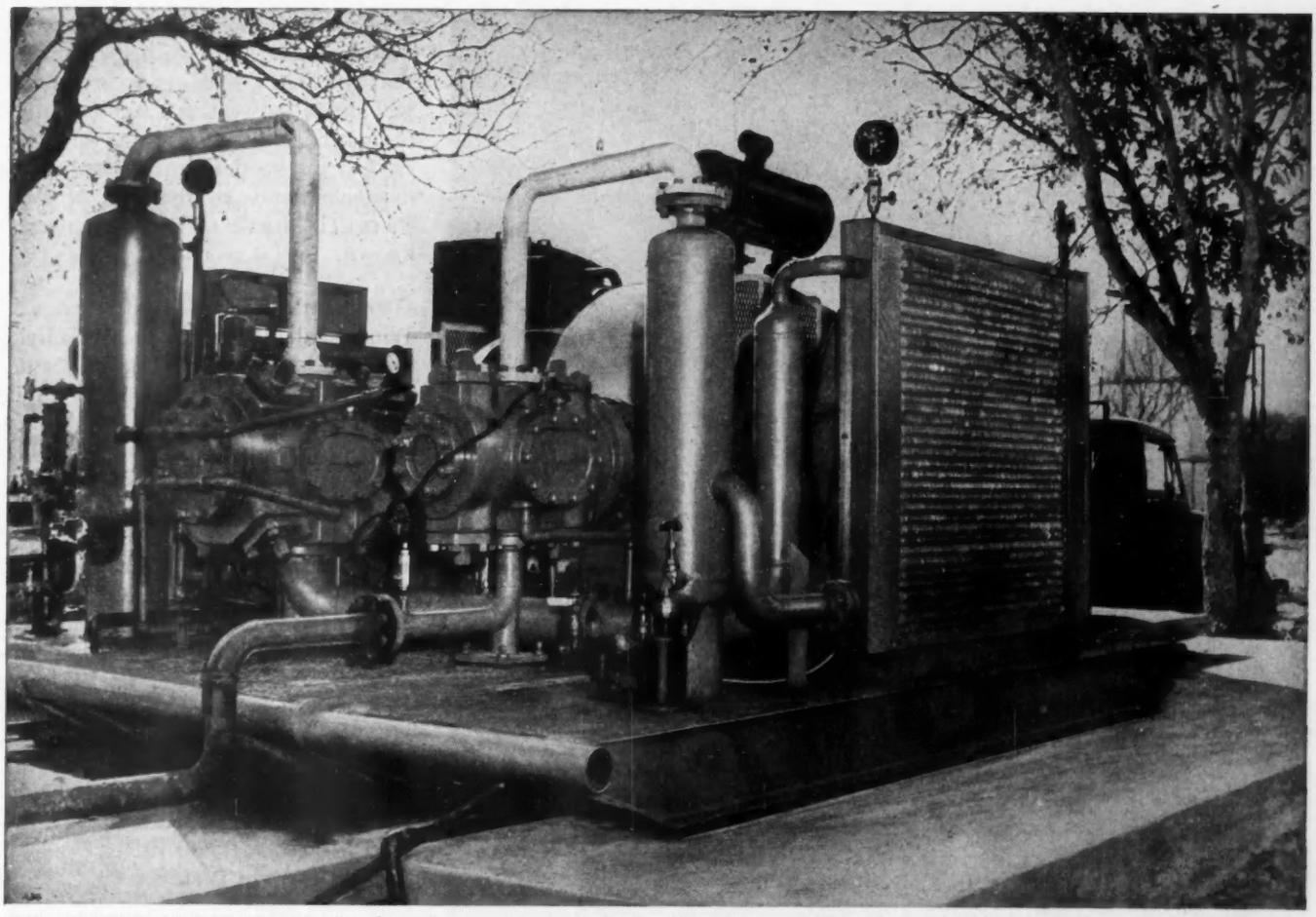
2. As the production of oil increases in Cuba, especially if this increase should continue at the accelerated pace of the past few months, income of the government will increase because of its 10 percent royalty of production.

Q. *What control, if any, does the Cuban government have on the disposition of crude petroleum produced in Cuba?*

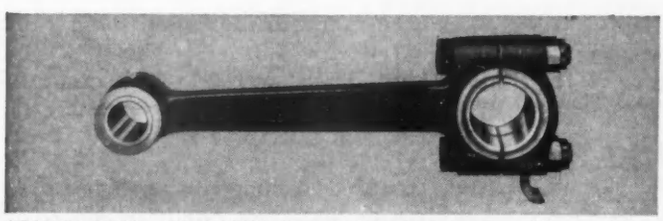
A. It is not yet proper to plan controls which the government should exercise over petroleum that may be produced in the future. Perhaps we may have to wait to learn the productive capacity of the different producing fields. If output increases a great deal in a short time in relation to domestic consumption, the 1938 law contains provisions that are applicable to storage, pipe lines and refining.

But we would have to approve special laws to govern the destination of crude oil that may be produced above a certain quantity, as well as the distribution of combustible by-products, lubricants and asphalt products that may be obtained from refining operations.

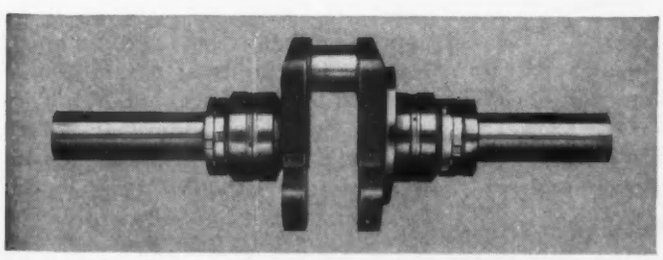
In conclusion, I believe that Cuba's possibilities for good oil production are quite favorable. Administrative laws covering exploration activities in all parts of the island have been promulgated. The question now depends upon more wells to be drilled in proven areas, and the intensity and extent of geological and geophysical investigations of potential areas throughout the island. —**The End**



THIS COMPACT WORTHINGTON "packaged" two-stage oil field compressor is working in an oil field at Refugio, Texas. These Worthington units range in pressures from 20 to 1500 psig. Capacities range from 0.1 to 9.5 million cubic feet.



FORGED STEEL, SEMI-MARINE CONNECTING ROD, with precision bored crosshead pin bearing. The bearing is grooved for oil passage and locked in position — renewable at small expense.



COUNTER-BALANCED, ONE-PIECE, FORGED STEEL CRANKSHAFT with dual counterweights to eliminate vibration, and sturdy, oversize shaft extensions for mounting driving sheave and flywheel.

Here's what oil men mean by a *rugged* compressor

Take a long look at Worthington's new "packaged" oil field compressor. Built to keep going through the roughest kind of duty, this powerful unit has won the acclaim of oil men everywhere.

Shown at the left are just two of the features responsible for the reputation these long-lived compressors are making for themselves in gas boosting, gas lift, well flowing, transmission, and repressuring jobs throughout the petroleum industry.

Find out for yourself about the modern, self-contained Worthington units. They're all equipped with our exclusive Feather* Valve — the lightest, tightest, most efficient valve made. See your local oil field distributor or write to Worthington Corporation, Section PC.4.3, Harrison, New Jersey.

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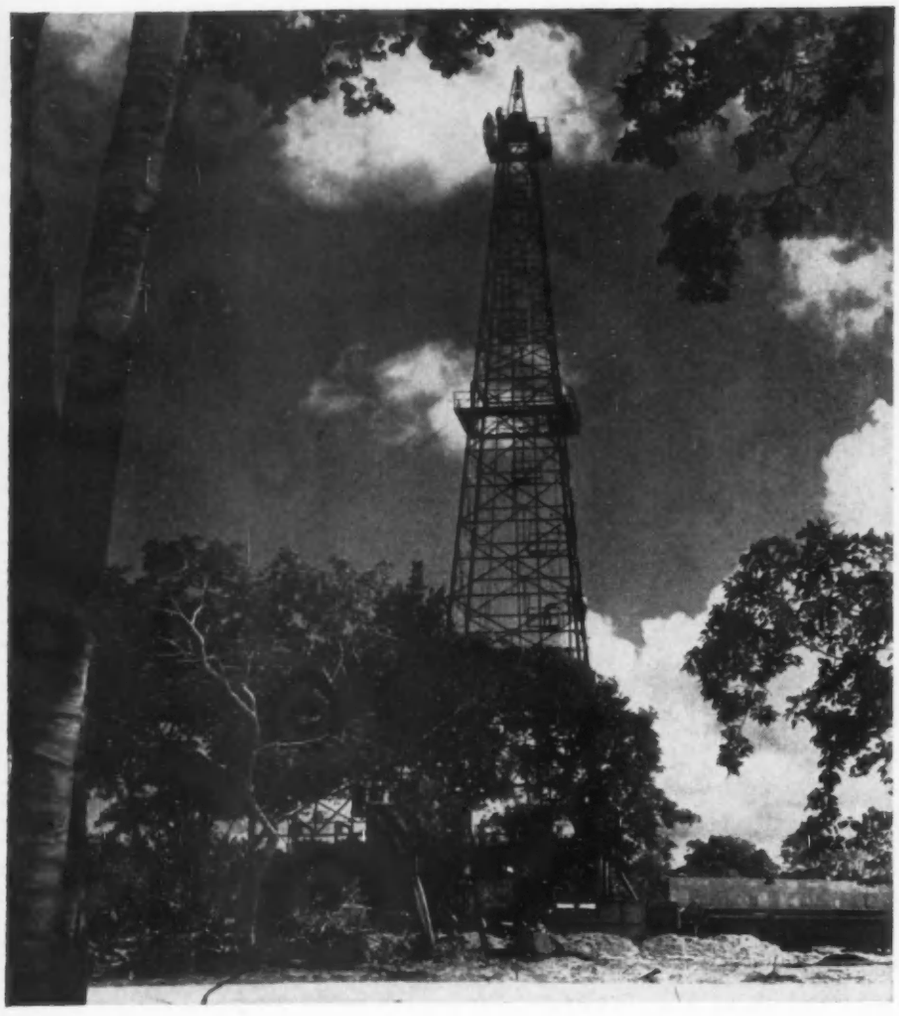


Well Drilled on Mafia Island

Well 1 derrick marks the site of the first test well to be drilled on Mafia Island off the coast of Tanganyika. The search for oil in East Africa is an enterprise of The British Petroleum Company in association with the Royal Dutch Shell Group. The well may be drilled to 12,000 feet.

a WORLD of OIL

By **DON KLIEWER,** World Oil Staff

Canada: Union Oil Company of California has confirmed reports of a new gas discovery in British Columbia, about 60 miles north of Fort St. John and 16 miles west of the British Columbia-Alberta border. At 3417-3437 feet a drillstem test resulted in gas production at a rate of 5 Mmcf daily. The well is jointly owned by Union Oil, Hudson's Bay Oil and Gas Company and the British-American Oil Company . . . Canadian Bishop Oil, Ltd.'s third well on a 320-acre Pembina lease was drilling ahead at 3800 feet as its Pembina 6-4 was completed as a 138-barrel-a-day flowing well at 5365 feet . . . Union Oil Company of California and Hudson's Bay Oil & Gas Company reported a fourth well at South Sturgeon Lake area, Alberta, came in flowing at the rate of 1992 barrels a day from 8331 feet. This well is two miles southwest of the 4000-barrel-a-day discovery well.

Cuba: American Leduc Petroleums Ltd.'s Cuban Canadian Petroleum Company has completed plans for a $500,000 20-well development program for its oil properties in the Echevarria field of Jatibonico in Camaguey province.

East Germany: A heavy rotary drilling rig has been bought by the State Geological Commission for test drilling in the Langensalza-Muehlhausen area, where gas is expected to be found.

France: Esso Standard Francaise, discoverer of the Parentis field, indicates that the field's 1955 crude production will range between 5.2 million and 7 million barrels . . . Results of Parentis 7, a test to determine whether the deposit extends to the west of Lake Parentis, have not yet been made known.

Germany: Gewerkschaft Elwerath-Wintershall AG. test well Meckelfeld-North 1 has discovered an as yet unassessed oil reservoir about half a mile north of the Meckelfeld field on the edge of the Elbe marshes . . . Gewerkschaft Elwerath's wildcat Wietingsmoor 1, situated 2000 feet southeast of Dueste 8—which earlier opened a new oil field between Diepholz and Bassum in the Weser-Ems district—has discovered oil in the Valendis at 2800 feet . . . Nation's total gas production of 5301 Mmcf for 1954 was 40.8 percent greater than that for the previous year.

Hungary: Official reports from Budapest say an oil deposit has been discovered about 190 miles west of Komlo, north of Pecs.

India: New oil sources described as capable of fulfilling a fourth of the nation's domestic requirements have been found in the Assam Basin.

Iran: Daily average production of crude oil for January was 227,000 barrels a day.

Israel: A drilling rig capable of drilling to 7000 feet has been moved to Massada, on the Dead Sea, by Water Projects Company on behalf of Lapidot Oil Company, which holds the concession there . . . Lapidot Oil has found gas deposits at a test well at Be'eri, it has been reported . . . Pontiac Oil Company's test well at Zichorn Ya'acov has reached its initial 10,000-foot objective without oil being found; however, it will be drilled to 11,000 feet with 3½-inch bits . . . Pontiac has scheduled two wildcats, one in the Kurdani area of Haifa Bay and one northwest of Beersheba.

Italy: It has been confirmed that a contract has been signed with Russia whereby Italy will buy about 3.5 million barrels of Russian crude to be paid for with tanker tonnage and oil drilling equipment . . . Negotiations of an undisclosed nature also are under way with Rumania . . . The gov-

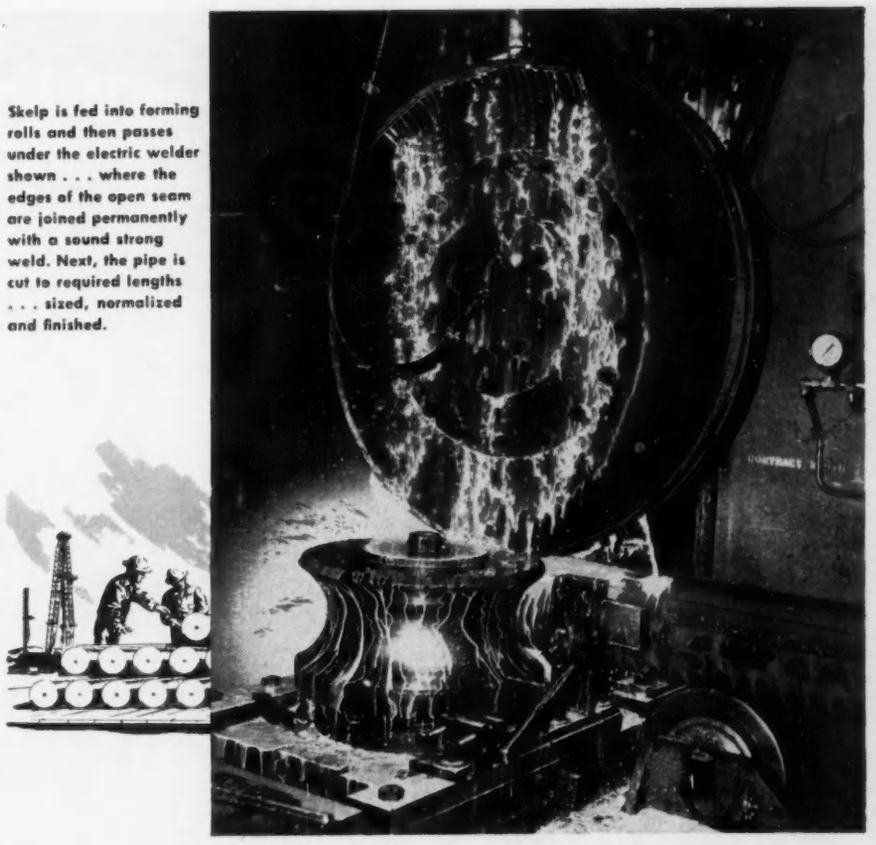
ernment has been asked for a production permit to allow prompt production from the 2000-barrel-daily well brought in recently on a 25,000-acre concession in the Cigno area of the Abruzzi concession about 16 miles west of Pescara by American International Fuel & Petroleum Company, a Gulf Oil Corporation subsidiary, and Italian Company of Montecatini. At 2500 feet, the well flowed 34 gravity oil.

Jamaica: Arrangements have been completed for delivery of a rotary drilling rig to the Base Metals Mining Corporation drilling site in the Montego Bay area, where a 6500-foot test was scheduled to commence drilling March 15.

Mexico: Biggest single producing well in 17 years is Acuatempa 3, located in the Faja de Oro. Well came in at 4550 feet with daily production of 9000 barrels through a one-half-inch choke . . . On the basis of extensive survey, exploratory drilling is scheduled to begin soon in Venado valley, just south of Ensenada in the state of Baja California. This will be the fourth drilling venture in the peninsula.

Pakistan: The Attock Oil Company, Limited, reports 1954 production of 1,279,855 barrels as compared to 1,158,308 barrels in 1953, with the increase afforded by the Dhulian field . . . A deep test at Khaur was drilling ahead at 6008 feet . . . Derrick foundations and cellar were almost completed and rig building was scheduled to commence at the West Pakistan Uch wildcat . . . Pakistan Petroleum Company's East Pakistan test well at Haripur, 14 miles from Sylhet, has spudded in . . . It is reported that Caltex may engage in oil exploration . . . Pakistan Petroleum is scheduled to undertake exploration activities in a 30-square-mile area of Ben Pahass in the Karachi division of Kalat, and a lease agreement reportedly is being negotiated between Baluchistan States Union and the company, which also is prospecting in the federated area of Mari Bugti.

Rumania: Fifty percent of wells drilled in 1954 were exploratory wells, marking an increase from 12 percent in 1953 . . . Production in 1954 is claimed to be 14 percent greater than in 1953 . . . Also reported is a 22,-



Skelp is fed into forming rolls and then passes under the electric welder shown . . . where the edges of the open seam are joined permanently with a sound strong weld. Next, the pipe is cut to required lengths . . . sized, normalized and finished.

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LINE PIPE in the Mid-Continent area

An ultra-modern, completely integrated steel mill... right in the heart of the fabulous Mid-Continent area... dedicated to prompt service to the petroleum industry. Lone Star's multi-million dollar electric-weld pipe mills... equipped with the newest, most efficient machinery ever designed... are turning out oil country tubular goods to the exacting specifications of the American Petroleum Institute. Lone Star is geared to *your* needs... with quick delivery a routine Lone Star service. Depend on Lone Star.

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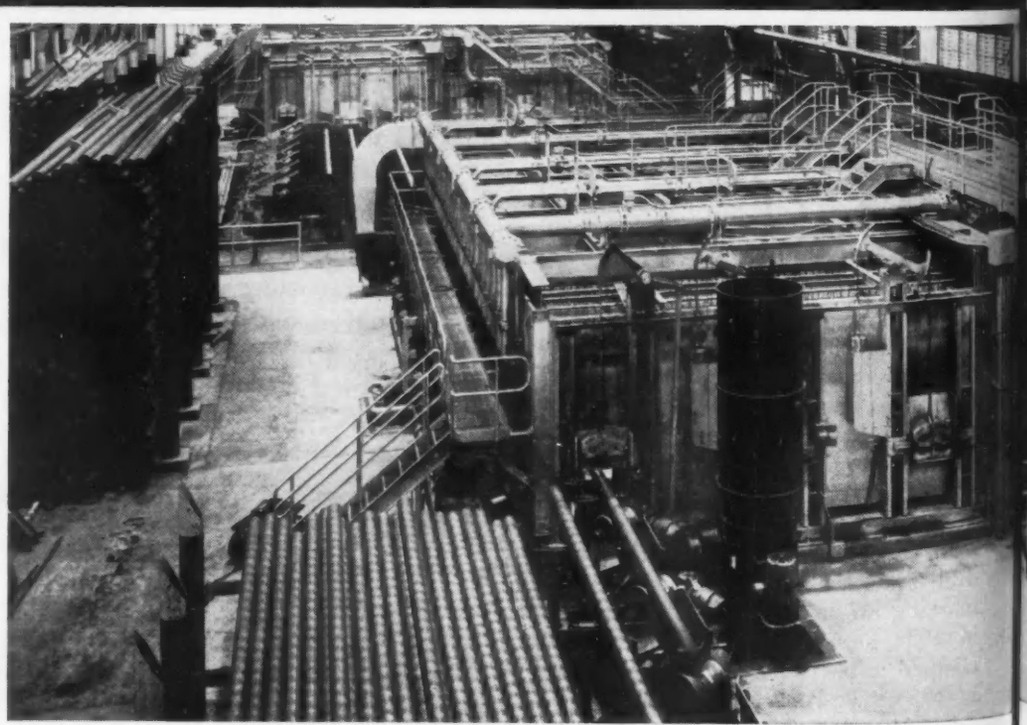
J&L STEEL

INTERIOR of high temperature 1650° F. furnace. The pipe moves through slowly from left to right on the conveyorized furnace bottom, passes out the exit door in the background.



OVER-ALL VIEW of J&L's new Seamless Tube Specialties Department at Aliquippa, Pa. High strength seamless steel pipe progresses automatically from the feed table in the foreground, through the heat treating furnaces in the center of the picture and into straightening, cutting and threading machines.

MORE HIGH STRENGTH CASING

J&L installs unique hearth type furnaces and quenching unit to meet driller demand

Drillers' growing need for an increased proportion of high strength steel casing is being met by J&L Steel through the addition of new facilities for the production of oil country tubular products.

Called the "Seamless Tube Specialties Department," the newest addition employs equipment of J&L design . . . makes possible the finishing of oil country casing by a quench and temper heat treatment that produces characteristics formerly attained through adjustments in the chemical composition of the steel. The result: by speeding up and improving its finishing facilities, J&L can furnish deep well drillers with more high strength casing up to 110,000 p.s.i.

If you're concerned with deep well drilling, J&L offers you a dependable source of high strength material.

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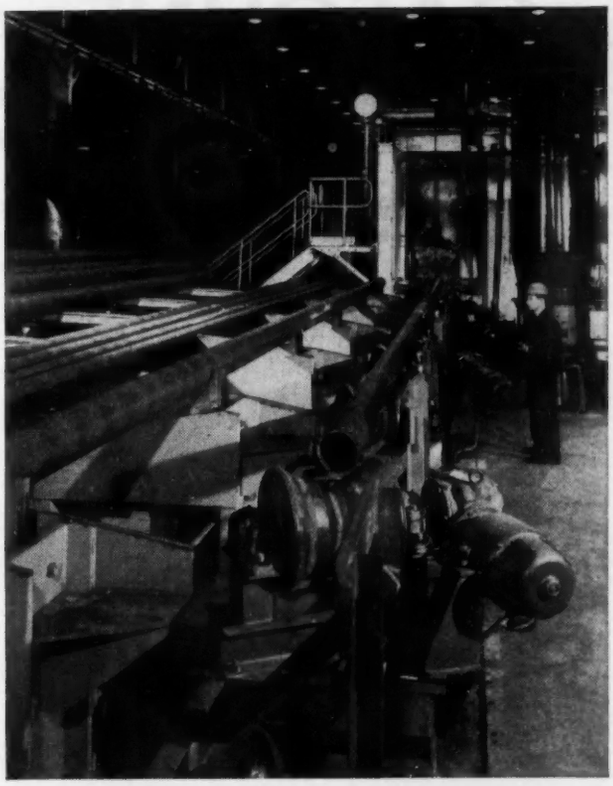

KENNETH NICHOLSON, turn foreman, checks 7-inch O.D. seamless oil well casing going into the No. 1 high temperature heat treating furnace. In this mechanically-operated, hearth-type, gas-fired furnace the pipe is normalized.

A THREE-STAND REDUCING MILL, foreground, at the exit end of the No. 2 tempering furnace, sizes the pipe to exact diameter. The No. 2 cooling bed in the upper left quarter of the picture moves and assembles the pipe for further processing.

GASOLINE or DIESEL?

Hercules engineers will assist you in the proper selection of the most economical type of engine for your particular equipment.

Many of our customers have asked us, "Which type of engine would be best for me?" Perhaps this same question has entered your mind at one time or another.

Of course, there are many governing factors which should be considered in selecting the proper type of engine for a particular piece of equipment. First of all, how much horsepower is needed? Is there a type of fuel which costs less locally . . . gas, gasoline, L.P. Gas, kerosene or fuel oil? How much money will be involved in the initial purchase? How much money can you expect to save by using a low-cost fuel? Will it be enough to offset the extra cost of a special type of engine? These and many other questions should be objectively answered before any engine is purchased.

We have no particular cause to champion and do not attempt to take sides or promote the use of one fuel over the other. As you know, we manufacture all types of internal combustion engines to operate on any fuel that is readily available. (Natural gas, L.P. Gas, kerosene, diesel fuel, gasoline, etc.)

The basic Hercules gasoline engines are adapted by minor changes to operate on different spark-ignition fuels. The Hercules diesel engines are compression ignited — specifically designed for operation on diesel fuel.

We have, however, maintained several similarities between the Hercules spark-ignited and the Hercules diesel engines which we think are very important. First of all, gasoline and diesel engines of comparable piston displacement have similar mounting dimensions and operating characteristics. Generally speaking, this makes it possible for equipment to be powered by either Hercules gasoline or diesel engines without creating any major installation problems. Thus, equipment manufacturers are able to supply customers with the proper type of engine to assure "top-notch" economies, according to the customers' operating conditions.

Another similarity between our gasoline and diesel engines, is that they both are of the 4-cycle design. The 4-cycle design is universally accepted and understood. This feature provides for less complicated engine servicing and in addition, service is readily available throughout the country.

What does all this mean to you? Maybe we can sum it up in our motto, "Engine Manufacturing Specialists Since 1915". Actually, we're custom engine builders with manufacturing facilities. Our engineering and sales policy is to design and sell engines to meet the exacting needs of our customers.

As a result, we have 70 basic models of gasoline and diesel engines which range from 3 to 500 H.P. They are available in many different designs . . . vertical and horizontal engines, special fuel handling equipment, various types of flywheels, etc. . . . in fact, we probably have an engine that will fit your particular needs to a "T".

Whether it's Agricultural, Oil Field, Automotive, Construction, Industrial, Marine or any other engine application, our engineers will gladly assist you in the proper selection of power for your equipment. Give us the details, so that we understand your problem, and we'll provide the answers to your power problems.

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500-foot drilling average per rig month during 1954 . . . Further overtures have been made in the hope of selling new and used oil field equipment to Pan Israel Oil Company and Israel Mediterranean Petroleum Company, who are drilling about 15 miles south of Jerusalem.

Russia: Several deep holes reportedly have been drilled in Galicia province, where crude production currently is claimed to be ten times larger than that prior to World War II, possibly because of renewed secondary recovery efforts.

Saudi Arabia: January crude production totaled 28,350,152 barrels, for a daily average of 914,521 barrels.

Uruguay: National Administration for Fuels, Alcohol and Cement (ANCAP) has announced probable existence of oil deposits following the classification of hydrocarbons in waters and gases extracted from a well near Montevideo.

Venezuela: Crude production reached a new record high of 2,111,418 barrels a day during January, as compared with 1954's daily average yield of 1,895,309 barrels and 1953's daily average of 1,764,988 barrels.

Yugoslavia: Currently, 20 wells in the Klostar-Ivanic field are producing a total of 675 barrels per day; however, with sufficient production equipment, output is expected to rise to 3375 barrels a day . . . Producing equipment for three of the wells was bought in Rumania, and equipment for five more producers is on order . . . Oil discoveries described as important have been reported in Dalmatia, a district of Croatia, between Biokovo, Vrgorats and Metkovic, in addition to the Dalmatian islands.

Red Chinese Claim Big Oil Discoveries

Communist China is claiming major success in petroleum prospecting and development in the five northwestern provinces of Shensi, Kansu, Ningsia, Chinghai and Sinkiang.

Red propaganda organs say many big oil basins have been discovered in the region and there is a possibility the northwest will become a major oil field of China.

First link of the Lanchow-Sinkiang railroad is now said to be transporting oil eastward from the northwest provinces to refineries. The railroad eventually will terminate at Urumchi

(Tihwa), center of northern Sinkiang's oil region.

The Peking government says "many oil derricks are operating at the foot of the Tienshan mountains" in the Urumchi area and that "the badly neglected Yumen oil field (in western Kansu province) has been restored and is developing at a rapid rate."

Total depth of wells drilled in northwest China during 1953 totaled more than 3 million feet, "four times the depth of wells drilled in the region during all of the last ten years of the Nationalist regime," claim the Reds.

Meanwhile, sharp increases in Communist China's synthetic oil output have been announced by the Peking government.

Liu Fang, vice director of the Ministry of Fuel Industry's Petroleum Administration claims that last year's production of synthetic oil from shale was about six times that of 1949. He said further that oil shale reserves at Fushun in northeast China have been found to be much larger than formerly estimated, with more rich deposits being discovered in other parts of the country.

Liu took special note of operations at Northeast 1 Oil Plant which, he declared, "each year consumes shale equivalent to a dike one meter (3.28084 feet) high and wide extending from the northern to the southern tip of China." Besides crude oil, this unit is said to make large quantities of diesel oil, gasoline and paraffin wax by dry distillation. Liquid ammonia and fuel gas are also turned out as by-products.

Liu claimed "thanks to the aid of Soviet experts, technical difficulties have been overcome, and the irrational production processes and administrative methods of the Japanese puppet regime have been done away with."

He said that during the Japanese occupation the rate of utilization of raw materials at Northeast 1 Oil Plant was only 65 percent, with large quantities of materials being wasted.

"But now the oil shale retorts have been improved. Shale fragments may now be used, thus raising the rate of raw material utilization. At the same time, the amount of work handled daily by the retorts has been increased.

"Experiments and technical improvements in other directions have raised the serviceability of machines

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HAMER G. P. PLUG VALVES

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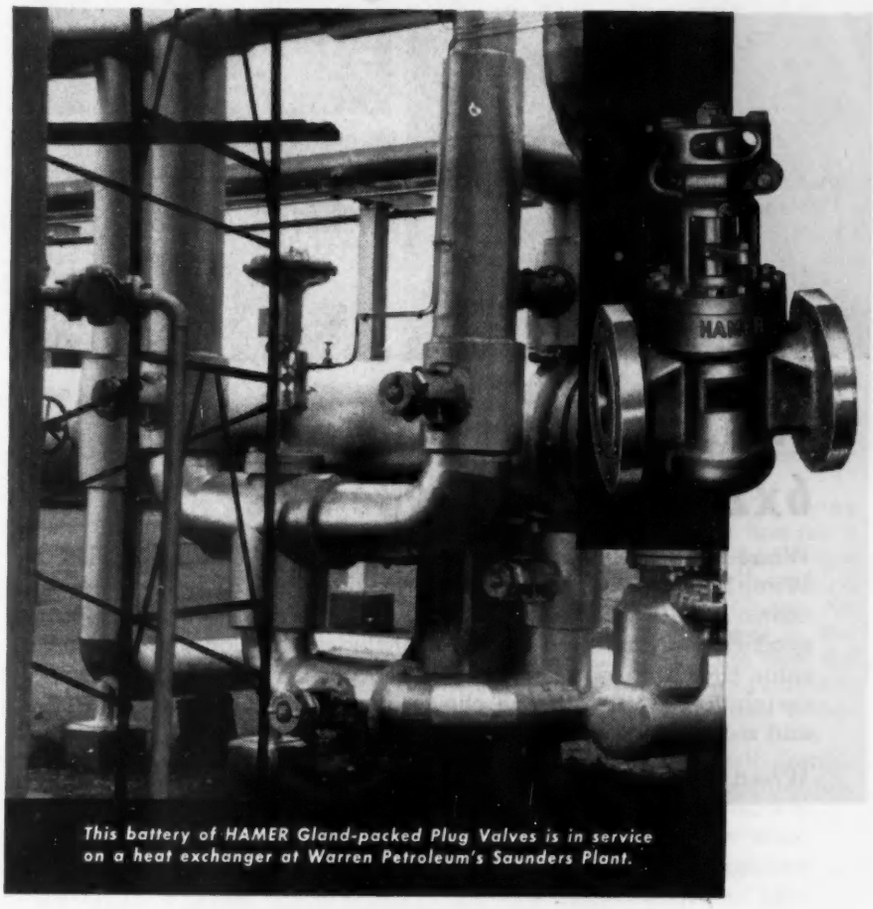
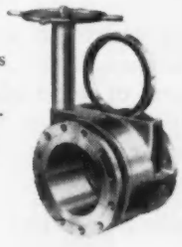


This battery of HAMER Gland-packed Plug Valves is in service on a heat exchanger at Warren Petroleum's Saunders Plant.

HAMER *Line Blind Valves*

Built for strength and durability, Hamer Line Blind Valves are the modern means of blinding pipe lines quickly and effectively. A one-man, one-minute operation. Cuts costs, and speeds up operations.



Shutting down to change valve packings costs dearly in time and money. That's why Warren Petroleum uses Hamer gland-packed Plug Valves. Not only can Hamer gland-packed plug valves be repacked under full operating conditions, but because of the exclusive plug adjusting nut, a feature of all Hamer Plug Valves, the valves can't stick or freeze. No matter what the time lapse or service you have positive E-Z turn control at all times.

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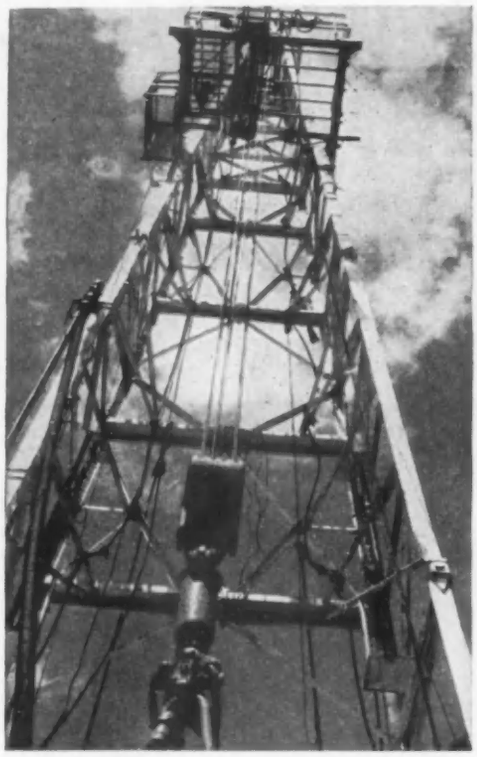

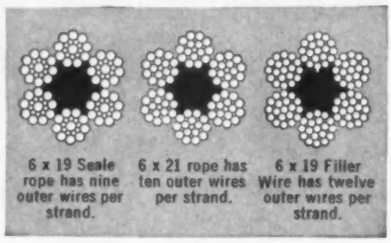
6 x 19 Seale rope has nine outer wires per strand.
6 x 21 rope has ten outer wires per strand.
6 x 19 Filler Wire has twelve outer wires per strand.

What can you do better with 6x21 *Red-Strand* wire rope?

What is 6 x 21 wire rope? It is sometimes called 6 x 16 Filler Wire. It is a construction of intermediate flexibility—between coarse 6 x 19 Seale and flexible 6 x 19 Filler Wire. 6 x 21 is a good choice where the operation includes abrasion and at the same time the rope is subjected to considerable bending. On certain types of duty the choice is vital to save time, effort and money.

When to use it? If, for example, your 6 x 19 Filler Wire rope is wearing out too soon because of abrasion, 6 x 21 with larger outer wires may provide much longer life. If severe bending is damaging your 6 x 19 Seale, a change to more flexible 6 x 21 may be profitable.

It is used on certain dragline jobs, vertical shaft hoists, drag and slackline scrapers, inclines, rotary and cable tool drilling rigs, and other equipment.

Can you use it to advantage? The best answer to that question comes from your Leschen technical man. Leschen representatives will help you get the most out of your wire rope. And with Hercules Red-Strand—as with all other Leschen wire rope, you are assured of ***higher-than-rated quality*** for ***longer-than-expected service.***

See your Leschen man soon. He can easily be reached through your nearby Leschen distributor.

Depend on Leschen's higher-than-rated quality for longer-than-expected service.

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and labor efficiency at No. 1 Oil Plant well above the standards achieved during the period of Japanese puppet rule."

11 U.S. Independents Given Consortium Certification

Eleven U. S. independent oil companies have been certified as responsible in initial steps leading to participation in the Iranian oil consortium. Certification has been announced by Price, Waterhouse & Company, the New York firm employed by the U. S. State Department to approve the reliability of applicants. The 11 firms have been approved by the Iranian government.

However, American Independent Oil Company, whose firm name was omitted from the clearance list, expects to be added to the approvals. Aminoil spokesman said the omission was not tantamount to denial of the company's certification. Aminoil has registered its appeal with the State Department, and it expects to receive a favorable decision.

The approved 11, and amount of participation requested by each, are:

Anderson-Pritchard Oil Corporation, 1 percent; Atlantic Refining Company, 2 percent; Cities Service Company, 5 percent; Hancock Oil Company, 3 percent; Pacific Western Oil Corporation, 5 percent; Richfield Oil Corporation, 5 percent; San Jacinto Petroleum Corporation, 1 percent; Signal Oil and Gas Company, 3 percent; Sinclair Oil Corporation, 3 percent; Standard Oil Company (Ohio), 3 percent; and Tide Water Associated Oil Company, 5 percent.

Next, the approved firms will be given a chance to study the details of the proposed agreement between participating consortium members and to decide whether they wish to participate.

The independents will have to establish their procedure for joint representation in the consortium, for all will be treated as one participant. Too, they will have to decide what share each will have.

Agreement terms limit the over-all total for independent companies to 5 percent. Requests of the 11 companies total 36 percent, so either individual quotas will have to be reduced or some of the proposed participants will have to be eliminated.

The offer for participation by independents ends April 29.

Rig in Israel
The Mediterranean Sea and the Egyptian border are both visible from the floor of this Lapidoth rig operating in the southwest corner of Israel, near Bani. The rig is powered by three diesels with torque converters. Mast is 133 feet high. Depth on the wildcat, operated by Kerr-McGee Oil Industries, Inc., of Oklahoma City, Okla., was approximately 11,400 feet with projected depth to 13,000 feet.

Socony-Vacuum's Italian Investment Is Insured

Socony-Vacuum Oil Company has received $8.4 million in investment guarantees on its investment in Socony-Vacuum Italiana, an Italian subsidiary.

Socony-Vacuum has obtained both types of insurance which are available under the investment guaranty program to encourage American investment abroad: one, for $5.6 million, assures currency convertibility so Socony could get its money out of Italy; the second is an expropriation guaranty to insure the company against any losses resulting from confiscation of properties.

Shell Drilling Offshore Well in Persian Gulf

The Shell Company is drilling a test well in the Persian Gulf on a concession acquired from Qatar in 1952. Under the permit, exploration rights were granted over a large area of the gulf extending beyond the territorial waters of the independent sheikdom

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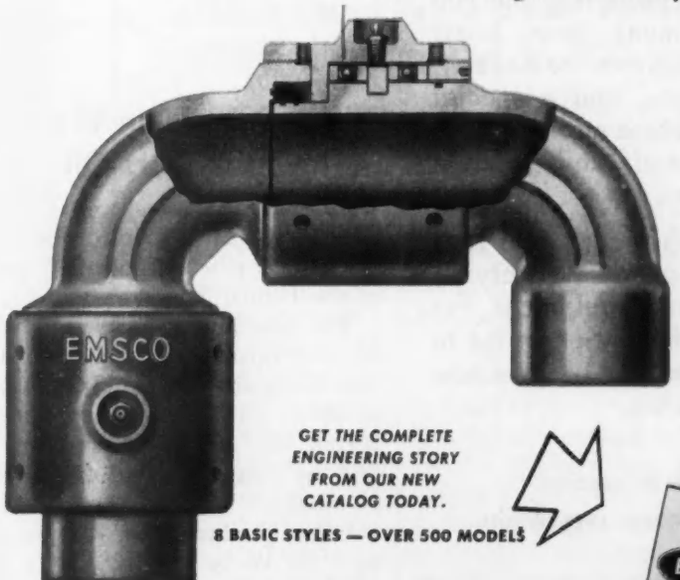

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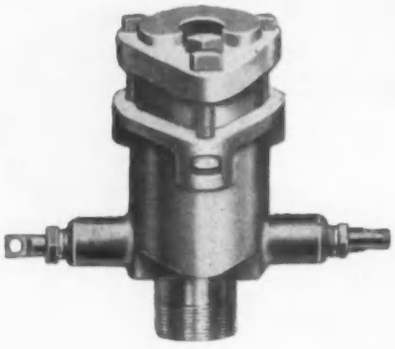

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The Ratigan 176 Stuffing Box receives lubrication directly from the well, thus providing continuous, self-lubrication without depending on the human element. Inner brass parts eliminate excessive packing wear, and a special shut-off feature makes it possible to shut off while repacking the box.

The #176 is a good unit that provides maximum safety to both men and equipment. For detailed information, refer to the latest edition of the Composite Catalog.

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situated on the northeastern coast of Arabia.

The rig, capable of drilling to 7000 feet, is being operated from a 1900-ton mobile steel platform set up about five miles from shore. The platform was fabricated in The Netherlands, erected at Doha, the capital of Qatar, and towed to the drilling site on two 1000-ton pontoon barges.

The platform can accommodate two drilling crews, and it contains storage space, refrigeration and air conditioning. Upon completion of the present well, the platform will be towed to a second offshore location.

Design of the drilling platform includes unique features found desirable in Shell underwater drilling operations in the Gulf of Mexico, Venezuela's Lake Maracaibo and in the South China Sea, off British Borneo.

Pemex Reports 1955 Oil Production Is on Rise

The first month of 1955 has shown a big jump in production and export, according to figures released by Pemex, Mexican nationalized oil industry.

Present production averages 265,000 barrels daily as compared to an average for 1954 of 233,000 barrels per day.

Average exports during 1954 amounted to 64,000 barrels per day. During the month of January, exports averaged 90,000 barrels daily, and contracts call for boosting this to 106,000 barrels per day during the coming months.

British Petroleum Well In U.K. Discovers Oil

Another producing well has been drilled at The British Petroleum Company's new oil field at Plungar, in the United Kingdom.

The new find is at Well 7, where British Petroleum's D'Arcy Exploration Company struck oil at a depth of about 2840 feet. When pumping begins, the well is expected to produce at a rate of about 40 barrels of oil a day.

Other producing wells in the same field are Wells 1 and 6, with a small production from Well 2.

Well 8 is already being drilled at Plungar and drilling of a ninth well is to begin shortly. Preparations are being made to drill Wells 10 and 11.

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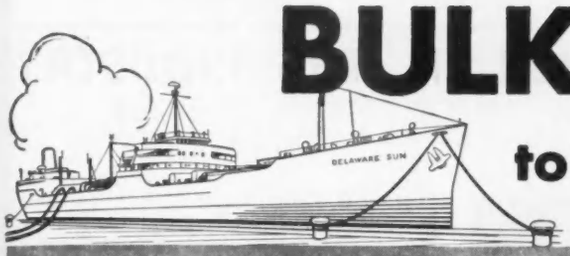

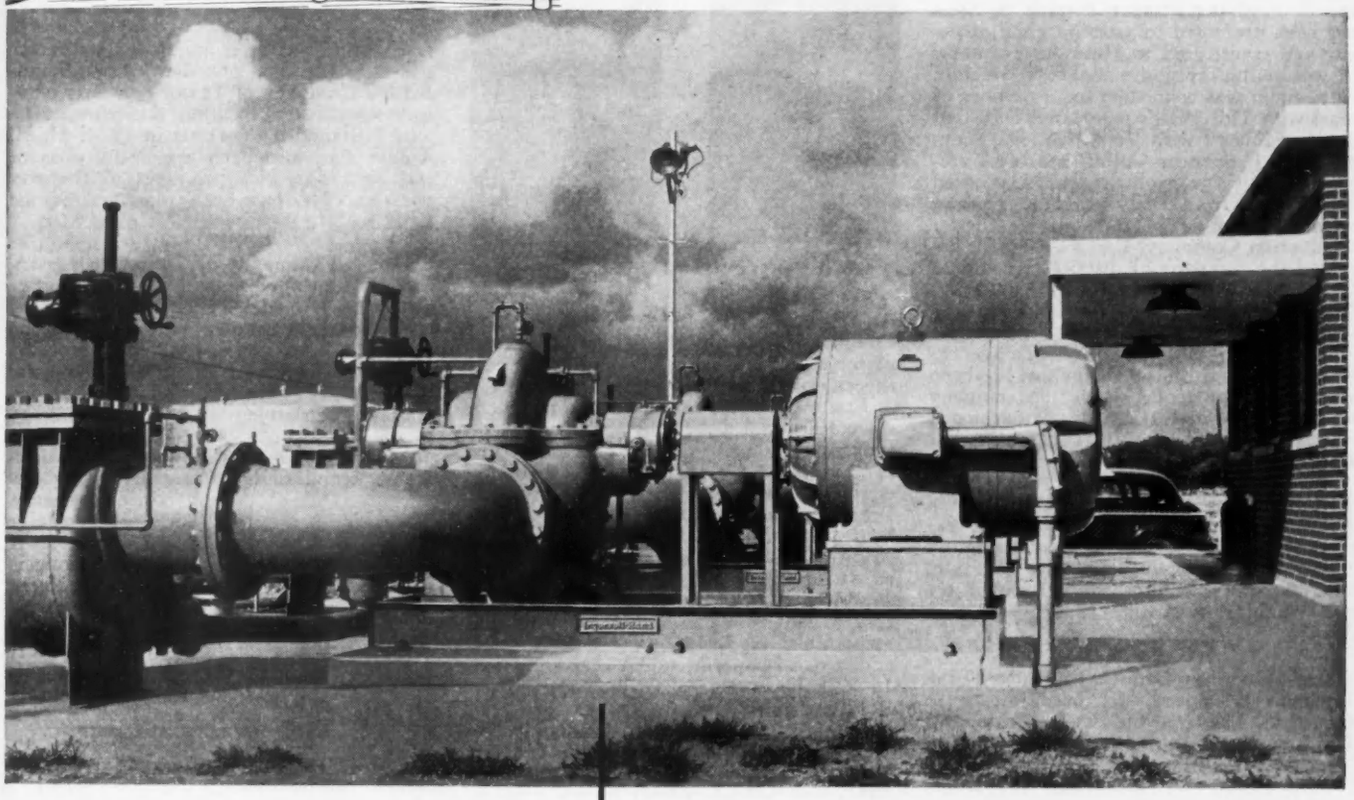

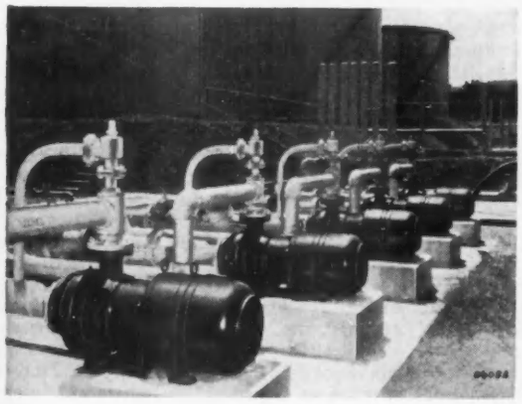

I-R close-coupled Motorpumps, like those shown above, are also widely used in smaller bulk loading stations. But whatever the size, Ingersoll-Rand centrifugal pumps have the inherent *stamina* that means dependable performance year after year.

3 Ingersoll-Rand ALV pumps at Sun Oil's "Sun Station" have combined capacity of 16,800 gpm.

Loading time is an important factor in the efficient operation of Sun Oil Company's tanker fleet. Hence the trend to high capacity in pumping station facilities—as illustrated by the large Ingersoll-Rand loading pumps shown above at "Sun Station" in Beaumont, Texas. Each of these pumps is designed for 5600 gpm at 134′ total head. Powered by 200 hp motors, they handle various grades of crude oil—for tanker loading and tank transfer service.

The entire operation of this tank station is designed for remote control from the modern, air-conditioned control room at the right in the photo above.

In tanker *unloading* too, I-R pumps have helped Sun Oil to set speed records. The S.S. Delaware Sun, for example, unloaded 213,000 bbl in 12 hours with three 4100 gpm Ingersoll-Rand HLV main cargo pumps.

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What's Happening

AMONG MEN IN THE INDUSTRY

Tennessee Gas Transmission Company has announced several personnel changes in the Geology department. **Francis B. Stein** has been promoted to assistant chief geologist and transferred to Houston. Formerly he was acting division manager at Wichita Falls. Stein was connected for a number of years with Tide Water Associated Oil Company and later with F. A. Callery, independent. **J. Spencer Collins** has been promoted to division geologist and transferred to Houston from Denver, where he had opened an office in 1954 for Tennessee Production Company. **Earl G. Griffith** has joined the company as district geologist in Denver. He was connected with The Texas Company in Montana and Colorado and for the last several years has been with The Chicago Corporation in Denver as division geologist. **Carl E. Jenkins** has been named district geologist for the company at Casper, Wyo. He was district geologist for Sinclair Oil and Gas Company at Casper before joining Tennessee Gas.

●

J. Julius Fohs has been asked to give a series of lectures on the geography, geology and resources of Soviet Russia by the Geology department at Rice Institute, Houston. The lectures are scheduled for the evenings of April 21, April 28 and May 5.

●

Alfred Gregory Catlow has joined the **Carleton D. Speed, Jr.** organization in Houston. The son of H. B. Catlow of Houston, he will do geological work in Texas and Louisiana.

●

William Ormond White has been elected president of **Trans-Tex Drilling Company** succeeding **George S. Buchanan** who was elected chairman of the board. Trans-Tex is a subsidiary of Husky Oil Company of Cody, Texas. Active in the oil business since 1934, White served with Standard Oil Company and Louark Production Company, which later merged with Carter Oil Company. He resigned as division manager of the Carter land department in 1941 to enter the oil and gas leasing business for himself and formed the Or-Association of America. Prior to joining Trans-Tex, White was president of the Ormond Corporation of Magnolia, Ark., and Shreveport.

●

E. T. Asplundh has been elected a director of **Southern Minerals Corporation,** oil and gas producing firm with headquarters at Corpus Christi, Texas. Asplundh is president of Columbia - Southern Chemical Corporation, a wholly-owned subsidiary of Pittsburgh Plate Glass Company, a director of Pittsburgh Plate Glass and vice president in charge of the firm's Cement division. He is also president of Standard Chemical, Limited.

E. T. Asplundh

A. W. Peake

Frank O. Prior

A. W. Peake, president of **Standard Oil Company (Indiana)** since 1945, and a director for 25 of the 34 years he has served the company, will retire as president May 3. **Frank O. Prior,** executive vice president since 1951 and a director for the past ten years, will succeed him. After a short time in the office of a petroleum and mining engineer consultant in San Francisco, Peake entered the oil industry as a roustabout in Ventura County, Calif. In 1916 Midwest Refining Company engaged him as superintendent in Wyoming's Big Muddy field. During the next 12 years he rose to superintendent of the gas department, chief engineer of the field division, and general superintendent of production. In 1926 he became a director of Midwest Refining, purchased five years earlier by Standard Oil Company (Indiana). In 1928, Peake was named president of Standard's subsidiary, the Dixie Oil Company, and two years later he was brought to Chicago as a director of Standard and vice president in charge of production. Prior joined Midwest Refining Company as a laborer on a "bull gang" in the Salt Creek field in 1919. In 1925 he was made superintendent of the company's electrical department. In 1928 he was selected as chief engineer and general operating superintendent of Dixie Oil Company; in 1929 he was elected vice president in charge of operations; and in 1930 he succeeded Peake as president. The following year he was named president of Stanolind Oil and Gas Company, a new company that took over Dixie and two other producing subsidiaries of Standard. In 1945 Prior was elected a director and vice president in charge of production for Standard. From 1945 until 1947 Prior also was chairman of the boards of Stanolind Oil and Gas Company, Stanolind Oil Purchasing Company, and Stanolind Pipe Line Company. For one year he was both chairman and president of the pipe line company. In 1951 he was elected Standard's executive vice president.

●

Richard P. Jeffery has been named maintenance superintendent of **Great Northern Oil Company.** A veteran in the oil industry, Jeffery was associated for 22 years with Globe Oil and Refining Company, which was recently purchased by the Pure Oil Company. From 1935 to 1940 he was process supervisor at Globe's Lemont Refinery and for the past 14 years was maintenance superintendent in charge of plant maintenance and new construction.

Warren R. Oates, formerly with Geophoto Services, Denver, has joined the staff of **Wm. Ross Cabeen and Associates,** Denver.

●

J. H. Todd has been appointed a director and elected a vice president of the **Standard Oil Company of Texas.** Formerly manager of the Exploration department, he joined Standard of Texas in 1954. **H. H. Kuseter** has also been appointed director and elected a vice president of the corporation. He has been manager of the Land and Lease division for nine years.

●

Union Oil Company of California has announced the appointment of **Basil Kantzer** as acting manager of operations for the Gulf Coast Division in Houston, relieving **Dudley Tower,** who has taken a temporary leave of absence. Kantzer formerly was manager of Union's Natural Gas and Gasoline department in Los Angeles.

●

John R. Suman, vice president and director of **Standard Oil Company (New Jersey)** since February, 1945, will retire March 31 after 44 years in the petroleum industry as engineer, geologist and executive. One of the nation's most widely known oil men, Suman has been a prime mover in oil and gas projects, especially initiating and developing conservation practices. During his career, Suman was instrumental in the development of the modern rotary drilling rig and drilling equipment which enabled oil men to tap deeper formations; he shared in pioneering the unitized drilling rig; and, in the field of reservoir engineering, he assisted in pressure restoration experiments that resulted in increased oil recovery in producing formations. He is also credited with a major part in the development that made Humble Oil & Refining Company of Houston, affiliate of Jersey Standard, a leading petroleum producer. He organized Humble's production engineering and research department. From 1912 until 1917, Suman was with the Rio Bravo Oil Company in Houston, serving as assistant geologist and later as chief engineer. He then joined the Roxanna Petroleum Corporation and served as technical superintendent of Texas and Louisiana for two years. He joined Rio Bravo again in 1919 as assistant to the vice president and general manager, and in 1925 served as vice president and general manager. He was also manager of the East Coast Oil Company of Mexico in 1923, and from 1923 to 1926, was general manager of Texas operations of the Associated Oil Company of California. Suman joined the Humble Company as a director in 1927 and was made vice president in charge of production in 1933. He was elected vice president and director of Jersey Standard on February 1, 1945, and in January, 1946, became a regular member of Jersey's Executive Committee.

John R. Suman

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Cities Service Oil Company (Penn.) has announced the election of **Edward G. Maddock** as director and vice president in charge of the marine division. Maddock succeeds **Christopher Story** who recently resigned. Maddock has been with Cities Service for 28 years and, since 1930, has been engaged in marine transportation.

•

Dr. Fred H. Poettmann has been appointed engineering supervisor for **The Ohio Oil Company's** Research Laboratory to be located near Denver. He had previously worked for American Gas Association, Lubrizol Corporation and Phillips Petroleum Company, where he was chief of the production research section before joining Ohio Oil in January.

•

Walter W. Fondren, Jr., Houston oil man, and **Richard T. Lyons**, president of Union Sulphur and Oil Corporation, have been elected to the board of directors and advisory committee of The National Bank of Commerce of Houston. Fondren was formerly with Humble Oil and Refining Company before becoming an independent oil operator. Lyons served as a geologist for many years with several major oil companies. In 1936 he came to Houston as vice president of Tide Water Association Oil Company, and since 1952 has been president and director of Union Sulphur.

•

W. G. (Tom) Sawyer has joined **Associated Oil and Gas Company** as comptroller. Prior to his new appointment, he was chief accountant, from 1947, for Frank Corzelius, Houston oil man and former owner-operator of Houston Industrial Gas Company of which Sawyer was treasurer and director. From 1939 to 1947 he was chief accountant for the late W. R. Davis, international oil operator.

•

John O. Larson has been elected secretary of **Standard Oil Company (New Jersey)** succeeding **A. C. Minton** who has retired. Larson previously was secretary of the executive committee.

R. C. McCurdy, president of Shell Chemical Corporation, has been elected to the board of directors of **Shell Oil Company**. With Shell since 1933, he was named exploitation engineer at Los Angeles in 1939 and, after assignments in New York and Washington, became chief exploitation engineer at Los Angeles in 1943. Two years later, he was appointed manager of the company's San Joaquin, Calif., production division. In 1947, McCurdy joined a Shell group company in Venezuela and was named general manager there in 1950.

R. C. McCurdy

•

William H. Hayes, partner in the law firm of Gasser & Hayes, has been elected a director of **Cosden Petroleum Corporation**. The new director is senior vice president and director of Dominguez Oil Fields Company.

•

The Texas Company has announced the following personnel changes at the Bellaire Laboratories, Research division of the company's Producing department: **B. D. Lee**, assistant director, Geophysical Research, and **K. C. ten Brink**, assistant director, Producing Research, promoted to assistant directors of research; and **A. S. McKay** and **J. C. Allen** appointed assistants to the director of research. Lee started with The Texas Company in the Geophysical division in 1932. After various assignments in Texas, Oklahoma, Kansas, California, South America and at Bellaire, he was made assistant director of Geophysical Research in 1948. With Texaco since 1947, ten Brink was advanced to his present position in 1951. He was formerly a chemical engineer. McKay joined the company in 1949 as a physicist at the Bellaire Laboratories, and Allen was employed in 1946 as a research chemist.

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John J. Arps has been named vice president in charge of the Economics and Evaluation department of **The British-American Oil Producing Company.** After various assignments with an oil company in Eastern Europe, the Far East, South America, and the U. S., he joined British-American as district engineer for their Gulf Coast area in 1940. He has since held positions of district superintendent, chief engineer, acting production manager and assistant to the executive vice president. British-American has also announced the following promotions and changes in the Central Division Exploration department: **R. C. Marmaduke,** former staff geologist for British-American in Dallas, promoted to division geologist, Central division, Oklahoma City; **H. A. Sykes,** geologist in Oklahoma City, promoted to district geologist in the Ardmore, Okla., district; and **W. H. Speckhard** named head of the new Geophysical department, Central division, Oklahoma City.

J. J. Arps

•

Frank R. Forsey has been appointed regional office manager for **Sun Oil Company, Ltd.** to succeed **James W. Cole,** who has been transferred to a special assignment. Formerly department supervisor at Toronto, Forsey joined the company in 1934.

•

Dr. Herman H. Kaveler, petroleum engineering and management consultant, has opened offices at 524 National Bank of Tulsa Building, Tulsa. Kaveler was assistant to the vice president in charge of production of Phillips Petroleum Company, before becoming a consultant.

•

Gerald J. Smith has been elected a director of **Pan American Production Company.** He is administrative vice president of the company. It has also been announced that **Earl V. Hewitt,** operating vice president of Pan American Production Company and vice president of Pan American Gas Company, has been elected a director of the latter company.

•

George E. Wagoner has been appointed exploration advisor of **International Petroleum Company, Limited** at Coral Gables, Fla. Wagoner worked for Humble Oil & Refining Company from 1930 to 1934. In January, 1935, he joined Carter Oil Company, becoming assistant chief geophysicist in 1937, a position he occupied until 1945 when he was appointed exploration manager of the Southern division at Shreveport. He was transferred to Denver as division manager in 1953, the position he occupied until joining International.

•

J. B. Cook has been elected vice president of **Woodley Petroleum Company.** Secretary-treasurer of the company since 1944, he will continue to serve as treasurer in addition to becoming vice president in charge of finance. Cook is also vice president and treasurer of Woodley Canadian Oil Company and a member of the board of directors of Great Northern Oil Company and Minnesota Pipe Line Company. **E. David Philley** was elected to serve as secretary of Woodley Petroleum. Formerly associated with the firm of Thompson, Knight, Wright & Simmons of Dallas, Texas, Philley joined Woodley in December, 1953, as manager of the Land department. It was also announced that **J. W. Boothe** has been elected assistant treasurer of the company. He has served as chief accountant since 1943 and as assistant secretary since 1948.

W. T. Smith has been named district geologist in the Abilene district office of Stanolind Oil and Gas Company and **H. D. Teel** has been named to succeed Smith as district geologist in the Lubbock office. Smith replaces **H. S. Edwards,** who has moved to Stanolind's division office in Fort Worth. Smith joined Stanolind as a geological scout in 1948. He served in various geological capacities and was promoted to district geologist in Lubbock in 1954. Teel goes to Lubbock from Stanolind's Midland office, where he was serving as area geologist at the time of his promotion. Teel joined Stanolind as a geological scout in San Antonio, Texas. He held various geological assignments at Wichita Falls, Fort Worth and Midland, Texas.

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Many other very attractive features. Ideal for ranch, country home, place to have friends, hold business conferences (present owner has had as many as 25 guests for a week at a time during business conferences).

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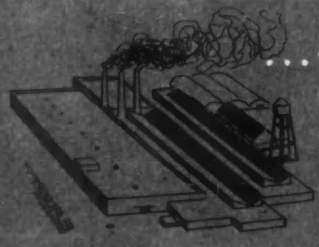

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DEATHS

Daniel C. Bohnsack, 69, independent oil producer of Barnsdall, Okla., died February 28. He was superintendent of the Harland Oil Company at Walco, Okla., before becoming an independent about seven years ago.

•

Guy McGowan, 70, former production division superintendent for the Tide Water Associated Oil Company, died February 27 at Olney, Ill. A native of West Virginia, he worked for Tide Water in Tulsa for 20 years before leaving that city in 1932.

Charles W. Stepp, 82, former field superintendent in Tulsa, Okla., for the late Oscar Howard, died February 26. One of the leases Stepp supervised was that on which the famous Red Fork field discovery was made in 1901.

•

John W. Pegg, 45, vice president of Shell Development Company, died February 24 in New York. He joined Shell in 1937 as an attorney and at one time was manager of the St. Louis, Mo., marketing area.

•

E. J. Kaplow, chief deputy, California Department of Natural Resources, Division of Oil and Gas, San Francisco, died February 7. Before assuming those duties, he had been deputy supervisor at the Santa Paula, Cal., district office.

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Harold E. Tips, oil executive, lost his life February 19 in a commercial plane crash near Albuquerque, N. M. He was vice president in charge of the Land department for the White Eagle Oil Company, parent company of Helmerich and Payne, Inc., Tulsa. He moved to Tulsa from San Angelo, Texas, in 1945 when White Eagle acquired the Cardinal Oil Company of which he was secretary-treasurer. He was named vice president of White Eagle two years ago.

•

Ronald S. Drysdale, 72, authority in the cutting oil field, died February 20 in Philadelphia. He had served as special representative in charge of metalworking and cutting oils for Sun Oil Company since 1920. Before joining Sun Oil he served with Yale and Towne Manufacturing Company, Remington Arms Company and the G. Whitfield Richards Oil Company.

•

Henry A. Rosenberg, 57, president of Crown Central Petroleum Corporation, died February 23 in Eccleston, Md.

•

Morris Price MacMillan, 74, widely known California oil man, died February 12. He was vice president in charge of production for the MacMillan Petroleum Corporation for 30 years and was one of the pioneer developers of the Signal Hill, Cal., oil field.

•

Gordon Allen, 49, sales representative for Magcobar, died recently in Shreveport. A veteran of more than 25 years in oil field service and supply work in the Ark-La-Tex area, Allen had been employed by Magcobar since 1950.

•

Walter A. Scott, 60, died February 11 in Houston. District sales manager for the American Manufacturing Company of Texas, he had worked in various phases of the oil business for more than 40 years in Pennsylvania, West Virginia, Ohio and Texas.

•

Oliver S. Ambrose, 71, manager of the Economics and Petroleum Analysis department of Tide Water Associated Oil Company, died February 15 in San Francisco. He joined Tidewater in 1920 as a construction engineer at Drumright, Okla., and later served in the operating department of Tidal Refining Company, a subsidiary. In 1928 he was named the company's petroleum analyst in New York. He was transferred to San Francisco in 1953.

•

Robert Green, 54, founder and president of the Green Pipe and Supply Company, Tulsa, died February 18. For many years he was associated with the Producers Pipe and Supply Company before establishing his own oil well supply firm six years ago.

•

J. G. Bartram, 61, internationally known consulting geologist for Stanolind Oil and Gas Company, died February 18 in Casper, Wyo. He joined the Roxana Petroleum Company in 1916 and worked throughout the Rocky Mountain area until 1923 when he went with the Mid-West Exploration Company. Midwest became part of Stanolind in 1931. Bartram was named division geologist for Stanolind in Tulsa in 1939 and had been consulting geologist since 1950.

•

Ernest Marshall Drake, 73, retired production manager of The Carter Oil Company, died February 16 in Santa Cruz, Calif. He was a native of Kansas and had worked out of Tulsa for Carter in Illinois and Oklahoma for 27 years. He retired in 1944 and moved to Santa Cruz.

Companies in the News

TIDE WATER ASSOCIATED OIL COMPANY is establishing an East Texas-North Louisiana district office in Tyler and has leased a substantial portion of the third floor of the Fair Petroleum building to house the company's expanded activities in this area. To the land department office already in Tyler, Tide Water will add fully staffed geological and geophysical departments, creating an exploration headquarters for company activities in the East Texas, North Louisiana, and Southern Arkansas area. The company's district production office will remain in Kilgore. Headquarters for Tide Water's Southeast Texas district office has been set up at 2330 West Holcombe Boulevard, Houston. Key personnel in the district office are N. E. Tanner, district landman; Hubert A. Moore, district geologist; L. D. Lott, production superintendent; and Kenneth Love, district geophysicist. The staff will supervise Tide Water's exploration and production activities along the Gulf Coast area from the Sabine River south as far as Victoria County. Prior to the setting up of this base of operations, district affairs were handled from Tide Water's Southern division office in the Mellie Esperson Building. The decentralization move was made necessary by substantially increased exploration and development work in this area. District exploration offices have also been set up in the Dale Building in Roswell, N. M., and in the Krohn-Miller Building, Billings, Mont. In Roswell, R. C. Powless will be district landman and C. E. Dorsey will be district geologist to handle exploration activities in New Mexico. At Billings, B. B. Barber will be district landman and H. J. Speer district geologist, to cover exploration activities in Montana east of the Continental Divide, and in North and South Dakota.

•

COMMONWEALTH OIL COMPANY recently elected **Byron L. Ramsing, J. L. McCord, Thomas H. Anderson, Alvin S. Moody, G. Burton Liese, Donald M. Lovejoy** and **D. V. Blocker** to the board of directors. Following their election, the board named McCord president of the firm; Anderson, vice president and treasurer; Blocker, vice president; **Robert E. Rickett,** vice president; **Edward L. English,** secretary; and **Shirley N. Griggs,** assistant secretary. The company was recently granted a three-year permit for stragetic minerals and metals in the Republic of Haiti. The development of the permits will be handled through Commonwealth's subsidiary, The Commonwealth Mining Company of Haiti.

•

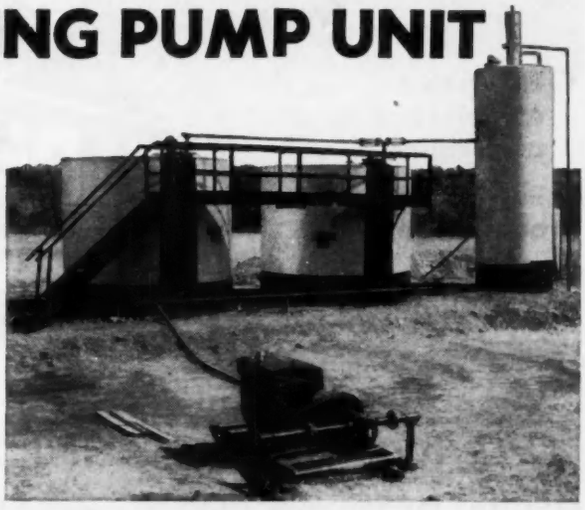
LION OIL COMPANY'S Production and Exploration division has established a new district office in Liberal, Kansas. The new district is a part of Lion's Central Region, headquartered in Wichita, under the management of **E. L. Maxwell.** The Liberal office will handle production and exploration activities in an area comprising four counties in southeast Colorado, the Oklahoma Panhandle and southwestern Kansas. **Jack V. Newman,** district landman, and **Glenn F. Thomas,** district geologist, are in charge of the new office.

•

SOCONY-VACUUM OIL COMPANY, INC., and its affiliates are contributing $324,470 during the 1954-55 school year for nearly 200 scholarships, fellowships and grants as part of its continuing program of financial aid to higher education in the U.S. and Canada. Of the total, $62,500 underwrites 21 research fellowships, $46,500 provides 64 scholarships, mainly in exploration sciences and various fields of engineering and $75,000 goes for 15 grants for scientific and engineering research. The American Petroleum Institute receives $70,000 from Socony-Vacuum for its program of fundamental research and special projects carried out in various colleges. Affiliated companies which share in these contributions are Magnolia Petroleum Company, General Petroleum Corporation, Mobil Producing Company, Inc., and Socony-Vacuum Oil Company of Canada, Ltd.

WISCONSIN-POWERED GATHERING PUMP UNIT

Transfers 100 Bbl. Tank in 3 to 4 Hours!



Typical of the many Wisconsin-powered Gathering Pump installations operating in various oil fields, is this hard-working unit in Creek County, Okla.

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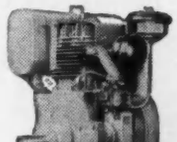
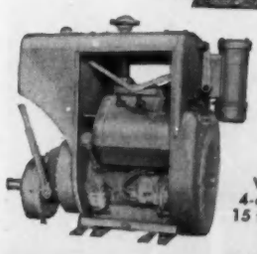


4-cycle single cylinder 3 to 9 hp.

2-cylinder models 7 to 15 hp.



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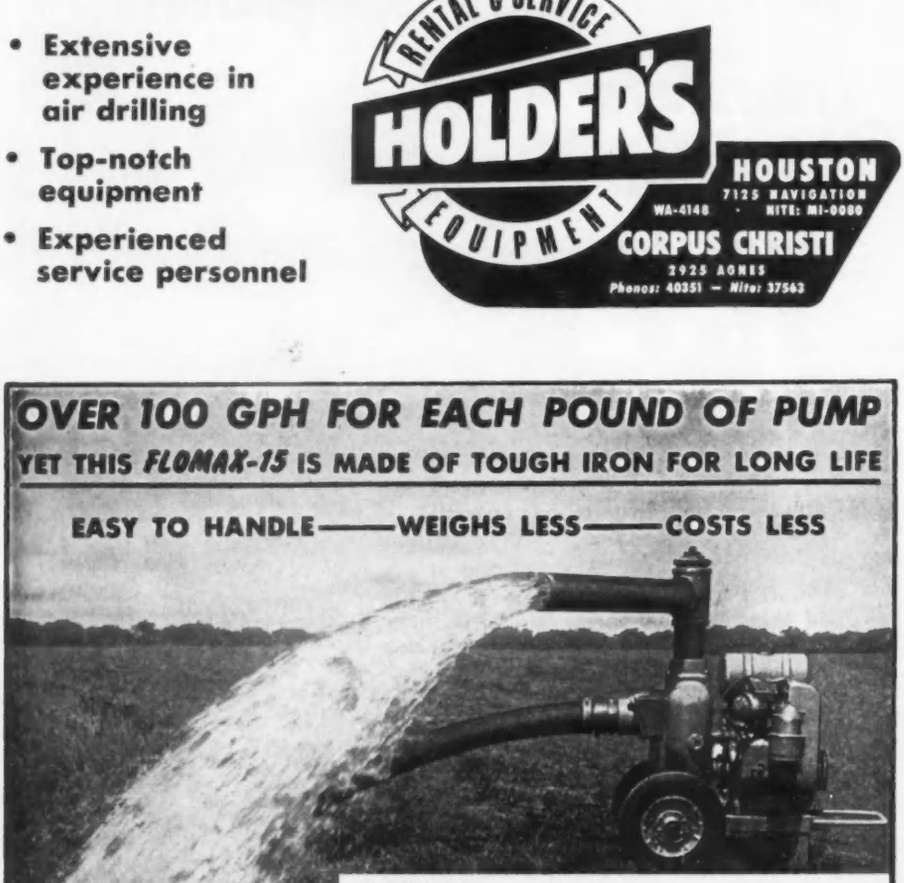

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THE ZAPATA DRILLING COMPANY, a recently incorporated concern with headquarters in Midland, has started operations. The concern has two rotary rigs in operation in the Grandfalls area of Ward and Pecos counties. The new company is an affiliate of Zapata Petroleum Corporation, an exploration, development and production organization. **George Bush** is president of the new drilling company; **Hugh Liedtke** is vice president and **M. R. (Mickey) Voltz** is vice president and drilling superintendent. Bush is vice president of Zapata Petroleum Company and is president of Zapata Offshore Company, another Zapata Petroleum affiliate. Liedtke is president of Zapata Petroleum and a director of Zapata Offshore. Voltz, who is the active administrative officer of Zapata Drilling Company, has more than 20 years' experience in oil well drilling work. He was associated with Fred Manning of Denver for 15 years in drilling work in Colorado, Wyoming and Montana. From 1948 to 1952 he was a partner in Lowell & Voltz, Inc., rotary drilling concern at Colorado Springs. That organization operated in the Rocky Mountain regions. **Calvin Crouse** of Monahans is toolpusher for the new company.

•

RICHMOND PETROLEUM COMPANY OF CALIFORNIA, subsidiary of Standard Oil Company of California, has changed the company name to **CALIFORNIA EXPLORATION COMPANY.** The new name, Standard announced, reflects more accurately the subsidiary's primary function, exploration for new crude deposits in foreign countries. The firm has been active for a number of years in South America.

•

TOKLAN ROYALTY CORPORATION has changed the company name to **TOKLAN OIL CORPORATION.** The company operates producing wells in Oklahoma, Kansas, Texas, Illinois and New Mexico. It also holds mineral interests in these and other states.

•

Stockholders of **MISSISSIPPI RIVER FUEL CORPORATION** and its subsidiary **NATURAL GAS AND OIL CORPORATION** will be asked to approve a merger of the two companies, it has been announced. Directors of the two companies, acting on management recommendations, approved submission to stockholders of a proposed merger agreement. It will be considered by Natural gas and Oil shareholders at the company's annual meeting May 26, and by Mississippi River Fuel shareholders at their annual meeting May 27. Both meetings will be in St. Louis.

•

ARROW DRILLING COMPANY has moved division offices from Tyler, Texas, to Shreveport. The office serves East Texas, Louisiana, Mississippi and Arkansas. **J. B. Daw** is new division manager and **Louis Roark** is assistant division manager at Shreveport. **Lloyd Hanson,** former division manager in Tyler, has been transferred to the company's headquarters in Tulsa as drilling superintendent.

What's Happening

AMONG INDUSTRY ASSOCIATIONS

MAKING PLANS for the new year are Mineral Sciences officers (left to right) Homer J. Steiny, secretary-treasurer; Benjamin F. Hake, chairman; and Harry P. Stolz, vice chairman.

Stanford Alumni Announce 1955 Information Program

The School of Mineral Sciences Associates of Stanford University, an organization made up of Standard trained petroleum engineers and geologists, is now organizing committees in 15 cities throughout the world to keep associates informed of their work. The group plans to concentrate attention on ways to maintain and increase the prestige and standing of the Stanford School of Mineral Sciences and to acquaint alumni with the current and future plans of the school.

Heading the group is Benjamin F. Hake, chairman; Rear Admiral Harry P. Stolz, U.S.N.R., vice chairman; Homer J. Steiny, secretary-treasurer; and Robert Sumpf and William J. Travers, Jr., members of the management committee.

Colorado Mines To Hold Engineer's Day April 15-16

Dr. Gustav Egloff, director of research for the Universal Oil Products Company, will be main speaker on the twenty-first annual Engineer's Day program at the Colorado School of Mines. Events will include technical sessions conducted by experts in the mineral industries, scholarship awards to outstanding Colorado high school seniors, prizes for technical papers by Mines students, rock drilling and mucking contests and guided tours of the Mines campus and the college's experimental mine.

John D. Henricks, of Underwood, N. D., is chairman of the student committee in charge of the event.

New Mexico Geologists Plan Uranium Field Trip

One of the first field trips through the Gallup-Grants-Uranium mining district will be included in the program of the ninth annual meeting of the New Mexico Geological Society to be held in Gallup May 13-15. Arnold Buzzalini, Pubco Development, Inc., is chairman of the annual meeting committee.

National Petroleum Council Names Imports Committee

Jake L. Hamon of Dallas, Texas, has been appointed chairman of the National Petroleum Council's new 35-man Committee on Petroleum Imports.

The committee was set up to make a factual study of petroleum imports, including their effect on the domestic industry, domestic economy and national security. When the study is completed, the committee will report its findings to the National Petroleum Council for further action.

Hines H. Baker, president of Humble Oil and Refining Company of Houston, was named vice chairman of the committee.

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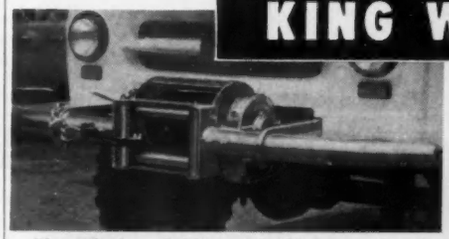
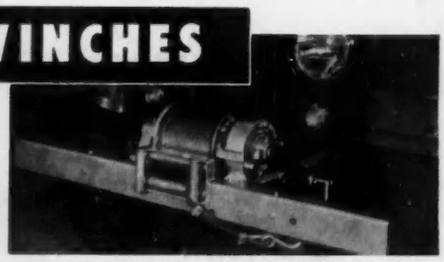


King Winch on R-140 and R-160 International



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Exploration Geophysicists Plan Gulf Coast Meeting

Two full days of technical sessions on the latest developments in exploration for oil and other minerals are planned for the tenth annual Gulf Coast meeting of The Society of Exploration Geophysicists to be held May 19 and 20 in San Antonio, Texas. P. E. Narvarte, consulting geopyhsicist, is general chairman.

P. E. Narvarte

The first nine Gulf Coast meetings of SEG were sponsored by the society's Houston section. This year the Houston, New Orleans and San Antonio sections will serve as joint sponsors.

Co-chairman of the meeting is W. L. Crawford, Petty Geophysical Engineering Company.

API Information Committee Names W. R. Huber Chairman

W. R. Huber, Gulf Oil Corporation, Pittsburgh, has been elected chairman of the Oil Industry Information Committee of the American Petroleum Institute for 1955. The committee advises in regard to the nationwide public relations program sponsored by the Institute.

Vice chairmen are L. R. Kamperman, Leonard Refineries, Inc., Alma, Mich.; Kerryn King, The Texas Company, New York; Richard Rollins, Atlantic Refining Company, Philadelphia; J. H. Sembower, Shell Oil Company, San Francisco; and Roy M. Stephens, Humble Oil & Refining Company, Houston.

New NACE Section Approved in New York

Rules and regulations of the newly-formed National Association of Corrosion Engineers, Central New York section, have been approved by the board of trustees of NACE Northeast Regional Division. Officers of the section for 1955-56 are Andrew Kellogg, Niagara Mohawk Power Corporation, chairman; F. C. Jelen, Solvay Process division, Allied Chemical and Dye Corporation, vice chairman and John F. Richter, Delrac Corporation, secretary-treasurer.

Kirk Jordan Appointed IPAA Area Representative

Kirk Jordan, former Wichita Falls, Texas, insurance man, has been appointed district representative for the Independent Petroleum Association of America in north and north central Texas, the Texas Panhandle, the Permian Basin and southern New Mexico.

He succeeds B. H. Vickrey, who recently was named membership director for IPAA, with offices in Tulsa.

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What's Happening

AMONG SERVICE AND SUPPLY MEN

Johnston Murray

Sam A. Wilson

A. M. Tullo

Vincent Gerbereux

Warner M. Kelley

Bill T. Mitchell

Wallace L. Reed

George A. Hanson

John R. Peasley

C. B. Evans

Guy Sullaway

Jack L. Mershon

Johnston Murray, ex-Governor of Oklahoma, has been made a vice president of **Welex Jet Services.** Murray will be in charge of the company's foreign activities and spend a large part of the time overseas.

Sam A. Wilson has been named general manager of **Dunham Tanks,** manufacturers of a complete line of tanks and tank equipment. From 1938 to 1944 Wilson was with the National Tank Company, and, from 1944 to 1946, he was with J. B. Beaird. In 1946, he moved to Maloney-Crawford Tank & Manufacturing Company, where he stayed until his recent assignment as general manager of Dunham Tanks. The plant and offices of the company are located in Minden, La.

Aloysium M. Tullo, works manager of **Worthington Corporation's** works in Harrison, N. J., has been appointed general manager of a newly-established division to be known as the Harrison division. Tullo will be responsible for all phases of Worthington's Harrison division operations including sales, engineering and manufacturing. **Clarence K. Hood,** a Worthington vice president, will be division sales manager; **George F. Habach** will be executive engineer; **Max A. Heyman,** Harrison works manager; **Thomas F. Quinlan,** division comptroller; and **Charles Schwalje,** foundry manager. Worthington also is establishing at Harrison a separate division of the corporation to be known as the Standard Pumps division. Feldman has announced that **Vincent Gerbereux** has been chosen general manager of this division. Gerbereux, who has been with Worthington since 1924, has been manager of the Centrifugal Pump division of the General Sales department since 1951.

Otis Pressure Control, Inc., has announced the appointment of two new division managers. **Warner M. Kelley,** formerly South Texas division manager of the caliper department, has been named South Texas division manager, and **Bill T. Mitchell,** former Southern Louisiana division superintendent, has been promoted to manager of the West Texas division. Kelly has been with the firm for ten years; he began as a sales engineer in Houston, was promoted to a division engineer, and subsequently was named to manage Otis' calipering department. Prior to joining Otis he was with Edwards Drilling Company and Pan-American Production Company. Mitchell has been with the company nine years, handling wire line service work for Otis in its Longview, Houma, and New Iberia branches.

Wallace L. Reed has been appointed district engineer at Houston for **U. S. Steel's Oil Well Supply division.** He transfers to Houston from New Orleans, where he has held a similar post since 1951. He joined Oilwell in 1949 as an engineer trainee at Alice, Texas. After his training there he was named assistant district engineer at Thibodeaux, La. He transferred to New Orleans in 1950. Retirement of **George A. Hanson,** veteran credit man in the Dallas offices, has also been announced by the division. Hanson joined Oilwell at Fort Worth in 1922 as a collection clerk. He transferred to the Dallas offices in 1932 and held various credit positions until 1946 when he was named credit manager of the Central Midwest Area.

Schlumberger Well Surveying Corporation has announced the following promotions and transfers: **E. A. Colle,** engineer in the Operations department in Houston, named assistant to the Southeast area manager at New Orleans; **J. J. Maricelli,** formerly area staff specialist for the Southwest area, promoted to assistant manager of the South Louisiana division at Gretna; and **John R. Peasley,** location manager at Mt. Carmel, Ill., transferred to the technical staff of the Operations department at Houston. **Vance E. Moss,** formerly at Mt. Pleasant, Mich., replaces Peasley at Mt. Carmel. **C. R. Miller,** formerly assistant to the division manager at Oklahoma City, has been transferred to Wichita, Kansas, as assistant division manager of the Kansas division; **C. B. Evans** has been named assistant to the division manager of Oklahoma City; and **Guy Sullaway** has been transferred from location manager at Cushing, Okla., to assistant to the division manager, Gulf Coast division in Houston. He has been replaced at Cushing by **G. H. Morris,** formerly location manager at Russell, Kansas.

Jack L. Mershon has been appointed sales manager for **Southwest Industries, Inc.,** in the area of Oklahoma, Colorado, Wyoming, Kansas, Nebraska and Arkansas. He was formerly with Stone and Webster Engineering Corporation as assistant field superintendent; Manila Electric Company as assistant power superintendent in the Philippine Islands and, later, as consultant on small petroleum process installations and Refinery Engineering Company.

K. R. Murphy has been named city salesman in the New Orleans office and **J. B. Emery** has been named city salesman in the Dallas office of **United Supply and Manufacturing Company.** Emery will work with **Roger Northrup,** regional manager for the company.

William B. (Ben) Adair has been promoted to chief engineer of **Macco Oil Tool Company, Inc.** He will also remain as chief sales engineer of the Houston division of the company. He joined Macco in February, 1953, as a sales engineer in the Houston division, and was promoted to chief sales engineer of the division in 1954.

Robert J. Stoup, plant metallurgical engineer at the Ambridge, Pa., plant, Spang-Chalfant division of **The National Supply Company,** has been appointed assistant chief field engineer, with headquarters at Tulsa. Stoup joined the company in 1936 as assistant metallurgist in the research department of the Ambridge plant. He was appointed plant metallurgical engineer in 1950.

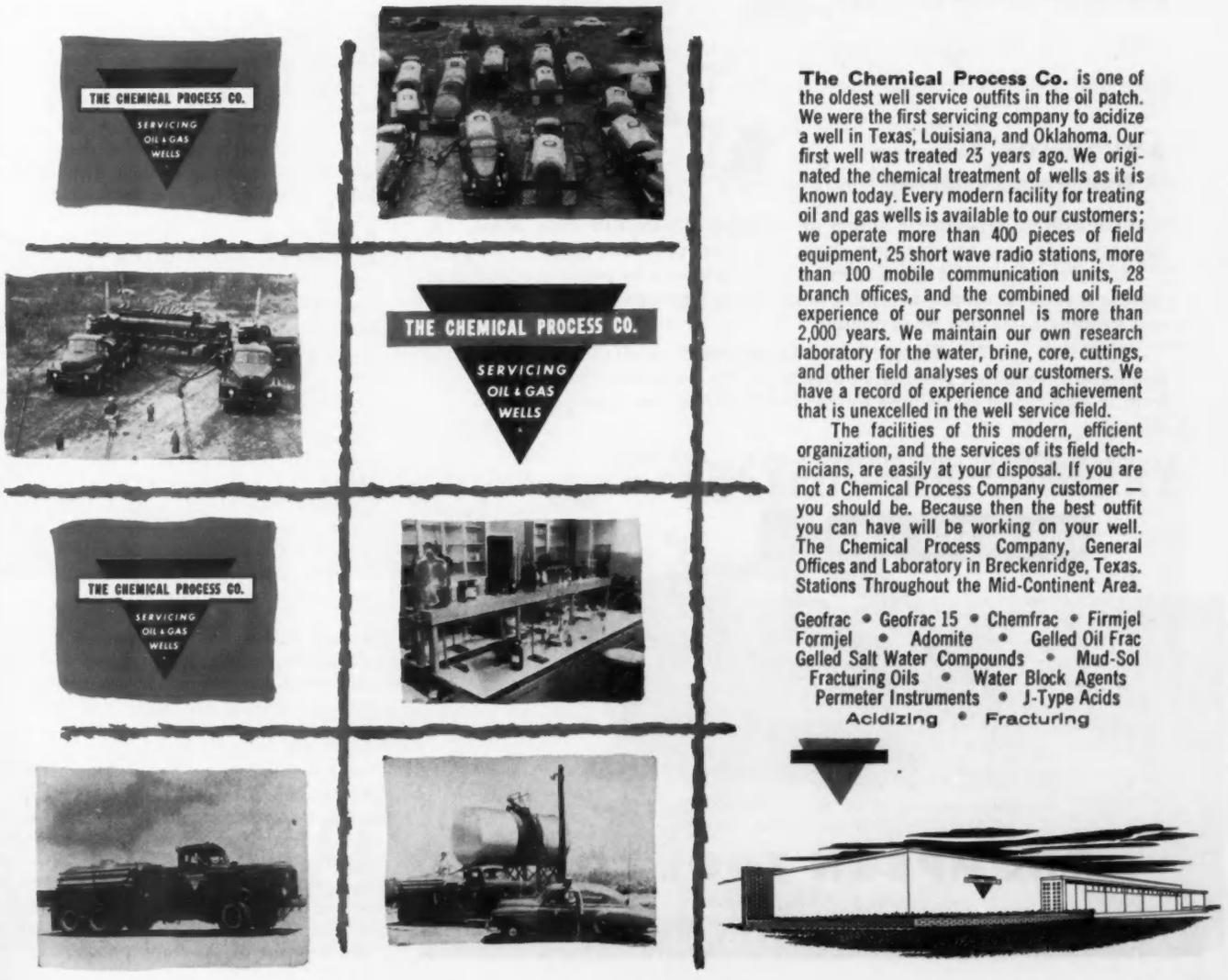
Henry Lee Martin has been named general manager of national sales and distribution at **Weatherford Oil Tool Company, Inc.** Martin has been with Weatherford for the past eight years. He comes to Houston from the firm's Eastern division headquarters at Nocona, where he was manager.

Hamer Valves Sales Meeting Held

Hamer Valves sales representatives from the U. S. and Canada met recently at the Hamer plant in Long Beach, Calif., for a four-day sales meeting. Shown left to right, top row, are Tom Martin, Tom Andrews, Sr., Ben Brundage, Vernon Zillgitt, Chuck Short, Howard Summerell, Ralph Stockton, Dave Preston, Tom Andrews, Jr., Joe Hall, Cleo Williamson, Ray Sexton, Fred Phipps, Paul Comer. Bottom row, Guy Warren, Andy Anderson, Shorty Hamer, Mel Hamer, Floyd Hamer, Morrie Holladay, Carl Gast, Phil McLaren and Al Ferguson.

Tube Turns Plastics, Inc., has announced the addition of **Earl Erich** to the company's technical service staff. A specialist in solving industrial corrosion problems, Erich began his business career as a research chemist for The Atlas Mineral Products Company, and later organized and headed the company's Thermoplastic division.

•


THE CHEMICAL PROCESS CO.
SERVICING OIL & GAS WELLS
THE CHEMICAL PROCESS CO.
SERVICING OIL & GAS WELLS
THE CHEMICAL PROCESS CO.
SERVICING OIL & GAS WELLS

The Chemical Process Co. is one of the oldest well service outfits in the oil patch. We were the first servicing company to acidize a well in Texas, Louisiana, and Oklahoma. Our first well was treated 23 years ago. We originated the chemical treatment of wells as it is known today. Every modern facility for treating oil and gas wells is available to our customers; we operate more than 400 pieces of field equipment, 25 short wave radio stations, more than 100 mobile communication units, 28 branch offices, and the combined oil field experience of our personnel is more than 2,000 years. We maintain our own research laboratory for the water, brine, core, cuttings, and other field analyses of our customers. We have a record of experience and achievement that is unexcelled in the well service field.

The facilities of this modern, efficient organization, and the services of its field technicians, are easily at your disposal. If you are not a Chemical Process Company customer — you should be. Because then the best outfit you can have will be working on your well. The Chemical Process Company, General Offices and Laboratory in Breckenridge, Texas. Stations Throughout the Mid-Continent Area.

Geofrac • Geofrac 15 • Chemfrac • Firmjel
Formjel • Adomite • Gelled Oil Frac
Gelled Salt Water Compounds • Mud-Sol
Fracturing Oils • Water Block Agents
Permeter Instruments • J-Type Acids
Acidizing • Fracturing

Frederick E. Romberg

Richard A. Geyer

R. E. Dixon

O. R. Payne

B. J. Milleville

Madden T. Works

Frederick E. Romberg has been appointed manager of the Gravity division of **Geophysical Service Inc.**, and **Dr. Richard A. Geyer** has joined the staff of the GSI Gravity division as chief geophysicist. Prior to joining the division, Geyer had served as research geophysicist for the Humble Oil and Refining Company. Romberg was formerly manager of the firm's Southern division in Houston. **Ray H. Wright** and **V. W. Teufel** have been promoted to managers of the Southern and Southeastern divisions respectively. Both were formerly supervisors in GSI's Southern division. **E. J. Toomey** and **Hal J. Jones** have been transferred to GSI from the firm's parent company, Texas Instruments Incorporated. Toomey will serve as marketing service representative and will specialize in foreign and marine contract work. Jones will serve as area geophysicist for the domestic area.

R. E. (Gene) Dixon has been appointed assistant district manager for the Ardmore district of **Welex Jet Services.** He has been with Welex approximately a year. Before coming with the perforating company, Dixon spent 18 years in oil well service work as a rotary driller, a toolpusher, and with mud service organizations. **O. R. (Mickey) Payne** has been promoted to the position of district manager for Welex at Gainesville, Texas. With Welex for four years in oil well service work, he worked successively as a rigman, a shooter and sales engineer of the Abilene district office before attaining his present position.

B. J. Milleville has recently been appointed chief engineer at **Edward Valves, Inc.**, subsidiary of Rockwell Manufacturing Company. He was formerly assistant chief engineer. He succeeds **David MacGregor**, Edwards works manager. Before joining Edward, Milleville was project engineer at Allis Chalmers Manufacturing Company.

Pioneer Specialties, Inc., announce the recent election of **Madden T. Works** as president. Connected with the oil field specialty equipment business for many years, Works was formerly with Cameron Iron Works, and, for a time before joining Pioneer, was engaged in product development work for his own account.

Rainey Elliott has been named president of the Supply division of **Jones & Laughlin Steel Corporation.** He was named general manager of the division in 1952. He had been vice president and director of the J & L Supply Company prior to its incorporation into J & L as a division. Elliott joined the organization in 1935 as a local store manager in Electra, Texas. Subsequently he was a salesman in Turnertown and Dallas and in 1941 was named sales manager. In 1952, Elliott was named director of sales and on August 1 of that year he was elected vice president and director of the Supply Company.

AN EFFECTIVE *THOMPSON* SHAKING GETS THE JOB DONE!

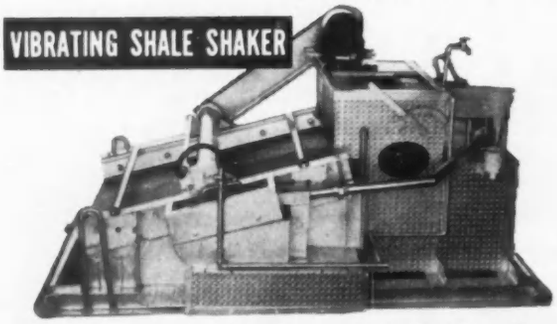
A THOMPSON Separator Is Necessary Equipment —

The consistent, dependable action of a **THOMPSON** Vibrating Shale Separator removes troublesome shale and abrasives from drilling mud ... vitally necessary for the job to be done in a way to prolong life of drilling tools, eliminating necessity of replacing expensive drilling muds, and keeping re-tooling at minimum.

That isn't all. The Sample Machine, standard on all **THOMPSON** Separators, operates simultaneously with the Separator, providing a foot-by-foot report on drilling formations, utilizing the same power and flowage.

A THOMPSON Separator works on any well depth.

Send for Free Illustrated Folder



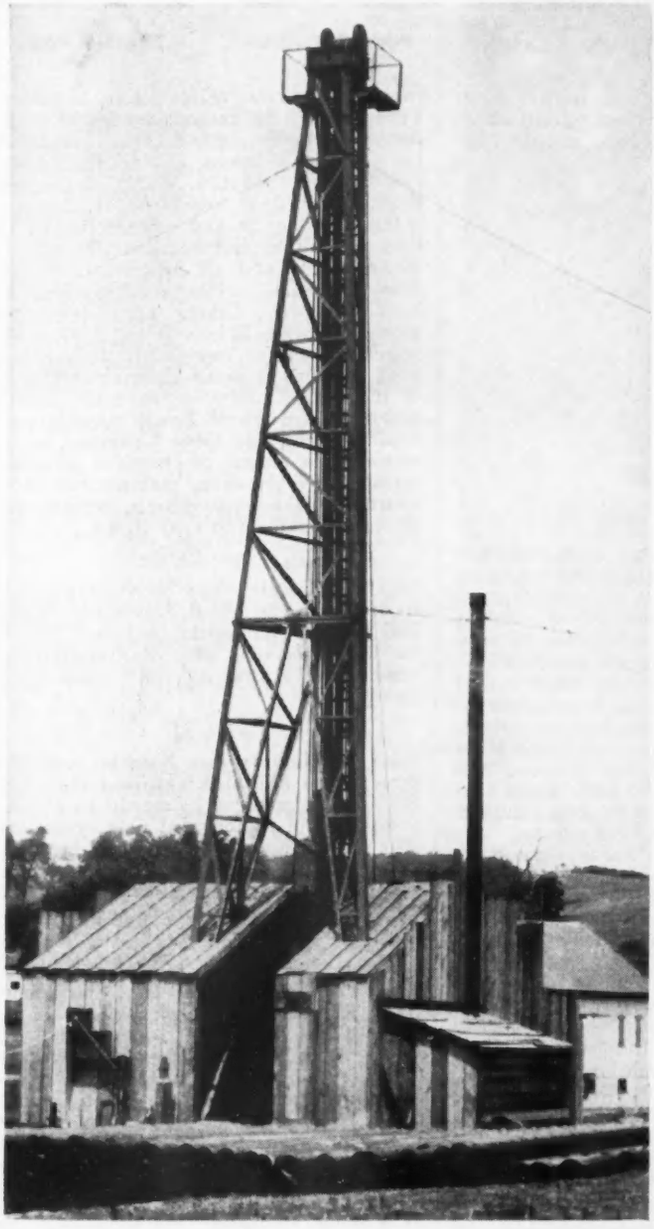
Manufacturers also of the famous **THOMPSON** Rotating Shale Separator and Sample Machine.

THOMPSON TOOL CO.

IOWA PARK, TEXAS

SOLD THROUGH SUPPLY STORES EVERYWHERE

UP TO 150-TON STATIC LOADS HANDLED BY 48-L SPUDDERS *with tripod derrick*



Now, you can set long, heavy casing strings with a spudder — the Bucyrus-Erie 48-L. Equipped with a new heavy-duty tripod derrick, available as extra equipment, the 48-L has ample derrick height (70'4") and capacity for handling static casing loads up to 300,000 lbs. when rigged for 10-part hoist.

Simple design permits easy setting up or dismantling of this special derrick. The entire assembly consists of only five units — upper section, main front lower section, two rear lower triangular legs, and a special substructure—plus the gin pole used in erection. Job-to-job moves are simplified, too, because the derrick can be disassembled and each unit transported separately.

The new derrick and substructure are available for 48-L's already in the field, or may be ordered with a new machine in place of the regular derrick. For complete details see your local Bucyrus-Erie distributor or write for a free copy of Bulletin No. TRI-D-1.

5554

BUCYRUS-ERIE COMPANY

South Milwaukee, Wisconsin

Bucyrus-Erie 48-L spudders, equipped with either tripod or regular derrick, handle top-to-bottom drilling to 6,000 ft., servicing to 7,000 ft.; swing up to 6,000 lbs. of tools.

BUCYRUS ERIE

G. N. Thresher

L. S. Aurand

Max E. Chandler

John H. Conroy

Jack R. Russell

Thomas H. Olson

G. N. Thresher, chief engineer, **Dowell Incorporated,** Tulsa, has been promoted to chief engineer—equipment, operations and maintenance. **L. S. Aurand,** project engineer, has been made chief construction engineer and **E. J. Echols,** development engineer, is now chief design engineer. Thresher will be responsible for all field operations and maintenance of equipment, radio communications, equipment records, manuals and bulletins. The Construction Engineering department under Aurand, will handle design and construction of all station facilities and buildings throughout Dowell. Design of all equipment used by Dowell in its various services, will be handled by the Design Engineering department under Echols. This includes research of service equipment design, layouts, sketches, detailed drawings and bills of material. Continuing at their various capacities are **Virgil Lewis,** general purchasing agent, and **Gene Lawrence,** works manager, in charge of chemical manufacturing, assembly shop, maintenance shop, instrument shop, spare parts, construction inventory and Saran tank lining.

Max E. Chandler has been elected controller and treasurer of **Beaver Pipe Tools, Inc.** Prior to joining the company, Chandler was associated with the Western Reserve Lumber Company as secretary and accountant.

John H. Conroy has been named sales director for **Shilstone Testing Laboratory.** He will be engaged primarily in the development of radiological field operations. The laboratory facilities have been expanded recently to include field radiological testing under the direction of **James M. Shilstone,** assistant manager of the New Orleans office.

Otis Pressure Control, Inc., has named **Jack R. Russell** as sales engineer in the West Texas-New Mexico area with headquarters in Hobbs. He has been with the company four years and formerly was a wire line specialist in the Hobbs branch. Prior to that he was assigned to the Corpus Christi, Texas, and Oklahoma City divisions.

Thermoid Company has announced the appointment of **Thomas H. Olson** as assistant division manager of the Chicago district office. Olson has had extensive experience in the mechanical rubber goods industry in Chicago and the surrounding area. His appointment is a part of Thermoid's program for expanded service to the industrial and farm markets.

Cliff A. Mace was recently appointed division manager of explosives sales for Hercules Powder Company replacing **H. Merrill Lynch** who was retired. **Julian O. Schofield** was named assistant division manager. Mace joined Hercules' Explosives department in 1933. Schofield, who joined the company in 1921, handled export sales for a number of years.

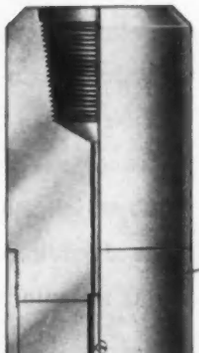
The Newest Fishing Lure

The

BOWEN KINGSTON FISHING MAGNET

Bowen Kingston Fishing Magnets are used to retrieve all types of small objects having magnetic attraction such as bit cones, slips, milling cuttings, tong pins, hammers, etc. These odd shaped, undrillable objects gather at the bottom of the hole as a result of tool failures and milling jobs or are accidentally dropped down the hole. Such objects cannot be engaged in any conventional manner and in many instances can be engaged and retrieved only with magnetic attraction.

Bowen Kingston Fishing Magnets are an indispensable accessory for all diamond coring operations. Small junk particles such as teeth chipped from bits, broken bearings, etc. can seriously damage a diamond core bit or curtail its performance. In a single run Bowen Kingston Fishing Magnets can completely cleanse the hole of all such particles, safeguard the bit from damage, and insure good performance.



Bowen Kingston Fishing Magnet
Patented

Keeper for Bowen Kingston Magnet

SIMPLE AND COMPACT

The Bowen Kingston Fishing Magnet is a simple, compact tool consisting of a Body, a non-magnetic stainless steel Sleeve, and permanent Magnets. There are no moving parts. The Plate protects the Magnets from any damage that might result from physical contacts. All sizes of these tools are provided with a circulating hole large enough for all standard purposes.

The magnet elements are made of the most advanced magnetic alloy which is magnetized as an assembly and specially treated to insure axial lines of force at the pole faces. The power of the Bowen Kingston Fishing Magnet is concentrated at its engaging end. This avoids any attraction with the walls of the casing and assures unrestrained lowering into the well.

CAN BE RUN ON WIRE LINE OR PIPE

Wire line operations have the advantages of speed and economy. Pipe operations have the great advantage of circulation, which can be used to eliminate settlings above the fish and to loosen the fish.

LONG LIFE

With proper care, the life of the Magnets can be prolonged indefinitely. Keepers are furnished with each Bowen Kingston Fishing Magnet to prevent magnetic dissipation while the tool is not in use. The magnetic attraction holds the Keeper in place and Cap Screws are provided to jack the Keeper off the Magnet.

SR BOWEN CO

MAIN OFFICE AND PLANT:
11008 SOUTH NORWALK BOULEVARD
SANTA FE SPRINGS, CALIFORNIA
EXPORT OFFICE:
30 ROCKEFELLER PLAZA
NEW YORK CITY, NEW YORK
EXPORT REPRESENTATIVE: VAL R. WITTICH, JR

James R. Homan

Roy C. Stringfellow

Willard H. Brien

Eugene J. Cassella

James R. Homan, formerly **Magcobar** sales representative in Oklahoma City, has been named California division sales manager. Prior to joining the company, Homan had extensive experience in drilling activities in the Middle East. **Roy C. Stringfellow,** former district manager in the Shreveport division, has recently been named manager of the division. He joined Magcobar in 1949 as a field service engineer.

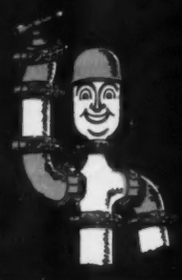
Willard H. Brien, who has been general oil field sales representative for **Well Equipment Manufacturing Corporation** in the Houston area for the past five years, has been transferred to Industrial Sales in the Gulf Coast area. He will contact refineries, chemical and petrochemical plants, engineering firms and contractors and other industrial plants as representative for both WECO and CHIKSAN products.

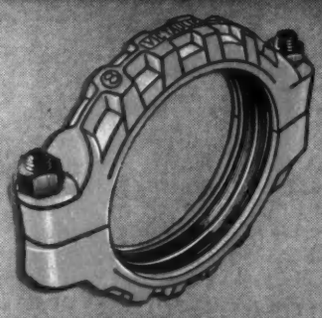
Eugene J. Cassella has joined **Beaver Pipe Tools, Inc.** as assistant plant manager. Prior to joining Beaver, Cassella was superintendent of the Bingham-Herbrand Corporation. Cassella joined General Motors at the Bristol, Conn., plant and worked his way up to assistant general foreman. After serving for a time as assistant general foreman, he was transferred to the Sandusky plant as forge shop superintendent. Later he was promoted to general supervisor of all forgings, annealing and ball wire operations. He left General Motors to accept the position of assistant superintendent at Bingham-Herbrand, later becoming superintendent.

M. S. Black, plant superintendent, has been promoted to works manager for **Fluid Packed Pump Company.** In his new assignment, Black will assist management in charting over all company and manufacturing policies. **Gordon Satterla,** formerly assistant plant superintendent, will replace Black. He will be responsible for all phases of manufacturing and plant operation.

VICTAULIC

METHOD OF PIPING





VICTAULIC COUPLINGS

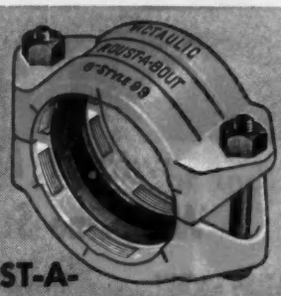
Styles 77, 77-D for standard applications. Simple, fast to install—sturdy and reliable. Sizes ¾" to 30". Style 75 Light-Weight Couplings for light duty applications. Sizes 2", 3", 4". Additional styles for cast iron, plastic and other pipes. Sizes through 60".

VICTAULIC FULL-FLOW FITTINGS

Complete line of Elbows, Tees, Reducers, Laterals, etc.—to fit all Victaulic Couplings. Streamlined for top efficiency, easy to install. Sizes ¾" to 12".

VIC-GROOVER TOOLS

Handy, on-the-job grooving tools that do the work in half the time. Light weight, easy to handle—operate manually or from any power drive. Automatic groove position and depth. Sizes ¾" to 8".



ROUST-A-BOUT COUPLINGS

Style 99 for plain or beveled end pipe. Best engineered, most useful plain end joint on the market. Simple, husky — easy and fast to install. Takes strong bull-dog grip on pipe. Sizes 2" to 8".

VICTAULIC SNAP-JOINTS

Victaulic's new boltless, speed coupling. — Style 78 — hinged into one assembly. Hand-locks for time and dollar savings. Sizes 1", 1¼", 2", 3", 4".

EASIEST WAY TO MAKE ENDS MEET

Promptly available from distributor stocks coast-to-coast. Write for NEW Victaulic Catalog-Manual 55-4G.

VICTAULIC COMPANY OF AMERICA

P. O. Box 509 • Elizabeth, N. J.

The Cooper-Bessemer Corporation has announced the promotion of **Robert F. Lay** to general sales manager and **Grant C. Woodard** to assistant general sales manager. Lay first became associated with Cooper-Bessemer in 1924 as a co-op student at the University of Cincinnati. Later he joined Baldwin Locomotive Company, where he became assistant sales manager. In 1940 Lay went to The Elliott Company as sales engineer. He later became chief engineer of Elliott's supercharging division and production manager. Returning to Cooper-Bessemer in 1946, Lay headed the company's stationary application engineering section until his promotion to chief engineer, products division. He was appointed assistant general sales manager for all company products, including engine-driven and motor-driven compressors, gas engines, diesel engines and gas-diesel engines. Woodard has had experience in both engineering and sales. He received his basic training at the company's engineering facilities at the factory in Mount Vernon, Ohio. He then served as application engineer and later as sales engineer working from the home office on engine and compressor installations for pipe lines and refineries throughout Ohio, Kentucky, West Virginia, Tennessee and Michigan.

Paul L. Gallagher has been appointed manager of pipe sales for the Claymont Steel Products department of **The Colorado Fuel and Iron Corporation.** Gallagher will be located at the Claymont Steel Products sales office in Wilmington, Del.

Harold M. Sauers

C. B. Truitt

Harold M. Sauers, first vice president of **Wico Electric Company,** has been elected president of the firm. **Allen L. Brownlee,** vice president, was elected first vice president and a member of the board of directors and **Remington H. Warner,** assistant treasurer, was elected treasurer. Sauers has been associated with Wico since 1936, serving several years as first vice president in charge of sales. Brownlee came to the company in 1942 in the research section of the Engineering department. He later became assistant chief engineer, chief engineer and vice president in charge of engineering. Warner joined Wico in 1952 as controller and was elected assistant treasurer and controller in 1954.

C. B. (Ike) Truitt has joined **Diamond Oil Well Drilling Company** in the capacity of general sales manager. He was formerly with Hanlon Waters, Inc., A. O. Smith Corporation and Grove Regulator Company. Just prior to his coming with DOWDCo, he was vice-president in charge of marketing and operations for Hiwan Petroleum Company of Houston.

Clayton L. Davis has been appointed technical service director of **Universal Atlas Cement Company.** He succeeds the late **Earl R. Bryant.** Davis joined Universal Atlas Cement in Chicago in 1930 as engineer in the Inspection Bureau. In 1937, he became assistant engineer of tests and two years later came to the cement company's New York headquarters. In 1943 he was appointed engineer of tests and continued in this activity until his recent appointment.

Francis D. Holden has been appointed manager of sales of **Macwhyte Company.** He joined the company in 1934 in the General Sales department and was named assistant general sales manager in 1948.

Erratum

In the article "New Method Simplifies Water Injectivity Profile Logging," Page 149, March, 1955, WORLD OIL, designation of the authors was in error. It should have read: A. S. McKay, The Texas Company, Producing Department, Research Division, Bellaire, Texas, and E. F. Egan, The Texas Company, Producing Department, New Orleans, La.

Be Safe — Be Sure — IT'S A KING

AR Wire Line Stripper
Latch Collar not shown

YOU ALWAYS HAVE
CONTROL
with a KING
Wire Line Stripper (Auto-Releasing)

POSITIVE LATCH
will not release by accident or surge of pressure.

SURE RELEASE MECHANISM
operated by rope socket striking bottom of stripper.

NON-SPARKING MATERIALS
eliminate hazard of fire from this tool.

CONVENIENT HAND HOLDS
makes for easier handling at all times.

SIDE OPENINGS
permit repacking while the wire line is in the hole.

These wire line strippers represent an outstanding advance in design and construction of tools in this class.

Sometimes referred to as "wipers" or "oil savers", they provide the oil industry many advantages that were not previously available.

Export: R. S. STOKVIS & SONS
17 Battery Place, New York 4, N. Y.

KING OIL TOOLS
210 TERMINAL ST. • HOUSTON, TEX • OSage 3-3421

Dow Chemical Establishes Subsidiary in Netherlands

The Netherlands Minister of Economic Affairs has granted The Dow Chemical Company permission to establish a wholly-owned subsidiary company, to be known as Nederlandsche Dow Maatschappij N.V., in Rotterdam, Netherlands.

The Dow application to do business in the Netherlands, as approved by the Dutch government, permits the subsidiary to import, manufacture and distribute domestically and abroad a variety of chemicals, plastics and magnesium.

The new company plans to build a manufacturing plant as well as tank storage, warehouse and dock facilities on a 50-acre tract leased for 20 years in the Third Petroleum Harbor at Rotterdam. The harbor is now being completed by the Port of Rotterdam, and construction on the plant site is expected to begin about mid-1955.

In addition to introducing basic chemical products to Dutch industry, Dr. Leland I. Doan, Dow president, said the subsidiary will supply technical information for their use to help stimulate increased production of finished goods within The Netherlands economy for export and domestic sale. A technical service and development group will be attached to the Dutch concern to assist its industrial customers in their manufacturing operations.

The board of directors consists of Dr. H. L. Woltersom, Dutch industrialist and banker who will serve as chairman of the board; Clayton S. Shoemaker, president of Dow Chemical International Limited, and W. Tyrone Gillespie, assistant to the president of Dow Chemical, both with headquarters in Midland, Mich.; Oliver E. Beutel, traffic manager of Dow's Texas Division, located at Freeport, Texas; and Theodore E. Knapp, manager of Dow Chemical International's office at Zurich, Switzerland.

McCormick Steel Company Opens Dallas Office

Frank J. Flanagan, Jr.

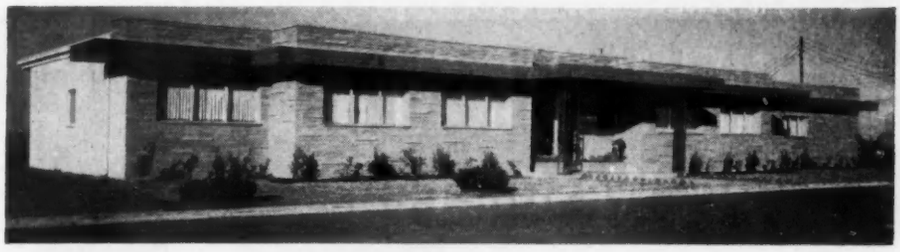
McCormick Steel Company has opened a Dallas office in the Grace Building.

In charge of the new office will be Frank J. Flanagan, Jr., resident manager of sales. Flanagan has been attached to the company's Houston sales office for the past two years.

Schlumberger Has New Office And Service Point in Colorado

Schlumberger Well Surveying Corporation has opened a new office and service point in Sterling, Colo., to serve oil producers in the Denver-Julesburg Basin. With the opening of the new location, Schlumberger services will be available to the oil industry through more than 130 field locations in the U. S. and Canada.

The Sterling location will be equipped to offer all Schlumberger services now in use in the Rocky Mountain area. H. F. Soerensen will be in charge of the new location. He was formerly stationed at Farmington, N. M. M. D. Kline, engineer, has been transferred from Sidney, Neb., to assist in carrying out field operations.



Tuboscope Moves into New Building

Tuboscope Company has recently completed and occupied a new executive annex to the main plant at Houston. The building contains 3800 square feet of space including a large reception room, conference room with adjoining kitchen and six large offices.

Here is your quickest--most convenient and economical source for

OIL COMPANY PRINTED FORMS

The Stock Form department of Gulf Publishing Company was established and is maintained to fill a need for a constant and immediate source of supply for field and office printed forms adapted to the use of oil companies, contractors, independent operators and related lines of business.

Now in general use throughout the industry, these forms are printed in large, economical quantities. They may be ordered in any desired quantity. Their utility and economy has been demonstrated by several thousand satisfied users, many of whom buy frequently in small quantities as needed because orders generally are shipped the day received.

More than fifty different forms are carried in stock for immediate shipment. Write today for a free Catalog of "Oil Company Stock Forms" or see "FORMS—Printed" in the Classified Index of your Composite Catalog.

Oil Company Stock Forms Dept.

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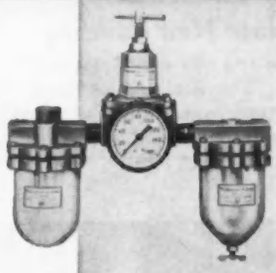
(Note—these forms are also available through local office supply firms in many oil centers. The name of your nearest dealer will be sent on request.)

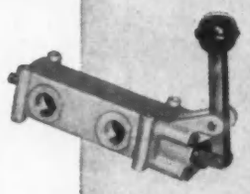
(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

PNEUMATIC NEWS from Westinghouse

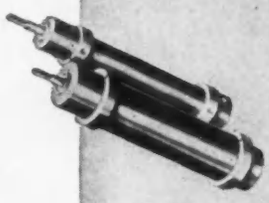
NEW LUBRICATION CONTROL . . . This new Westinghouse Type R-1 Lubricating Control Unit gives your air system complete protection. It accurately regulates air pressure —prevents air waste and excessive pressure. It regulates the injection of oil in proportion to the amount of air . . . *meters* the flow . . . *atomizes* the oil. It *removes* water and solid particles from the air stream. One size handles *all* requirements from 4 to 85 cfm at pressures up to 125 psi.



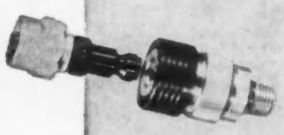
NEW FLOW VALVE . . . This new Westinghouse Type "D" Pilotair Valve controls the flow of air, oil, or water at pressures up to 250 psi. It comes as a two-way, three-way, or four-way valve with lever, treadle, pedal, button, cam, solenoid, or pneumatic operation. New seal and construction assure long life and low maintenance.



CYLINDERS . . . Westinghouse makes them in diameters from 1½" to 10", with stroke lengths up to 42". Single or double acting, with or without adjustable cushioning, for foot, flange, or pivot mounting.



PLUG-IN COUPLERS . . . Westinghouse makes these full-flow, heavy-duty, quick couplers in both the Push Type, which can be connected and disconnected with one hand, and the Sleeve Type. Two series: Interchange, for use with other makes of couplers, and Standard.



FOR QUICK SERVICE LOCALLY

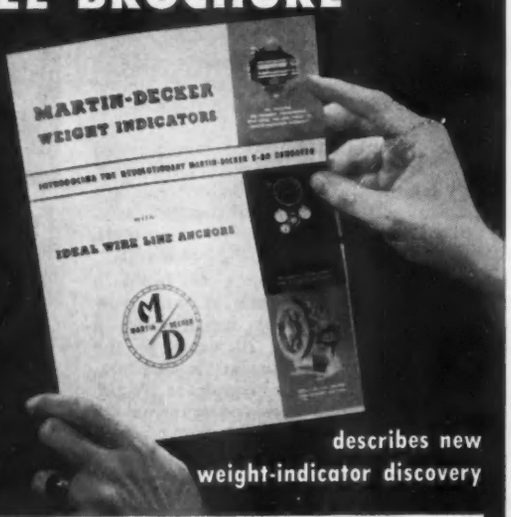
...and complete facts about the Westinghouse line of quality pneumatic controls, consult the Westinghouse Air Brake Distributor listed in the classified phone directory under "Cylinders: Air."

Westinghouse Air Brake COMPANY

Industrial Products Division

WILMERDING PENNSYLVANIA

FREE BROCHURE



describes new weight-indicator discovery

Bulletin P-10 features the Sensater, a marvelous new kind of Ideal anchoring-type diaphragm pressure transformer for Martin-Decker Weight Indicators. The rugged Sensater strokes like a piston, but has no friction-causing piston-rod or packing. It always sends accurate, no-lag, hydraulic signals to the drilling-control instrument. Write Martin-Decker, 3431 Cherry Ave., Long Beach 7, Calif., Dept. B-2.

MARTIN-DECKER CORP.

HOME OF THE WEIGHT INDICATOR — LONG BEACH, CALIFORNIA

✓ Check S & R Facilities for THESE . . . .

Mud Pits · Tool, Change and Utility Houses · Conveyors · Telescopting Pole Masts · Pump Suction Strainers · Substructures · Fabrication · Unitization · Equipment · Machinery · Power Application and Devices · Equipment Repair · General and Special Machine Shop Facilities.

S & R TOOL & SUPPLY CO.

P. O. Box 1755 • 155 McCarty

Houston 1, Texas

Export: 45 Rockefeller Plaza, New York 20, N. Y.

K. M. Lamer

W. G. Pitezel

Six Sales and Service Men Receive Promotions at Franks

Franks Manufacturing Corporation has announced the following personnel changes to mark the beginning of a division of its sales and service force: K. M. Lamer will fill the post of assistant sales manager at Tulsa; W. G. (Bill) Pitezel will take over Lamer's former position in Odessa as West Texas district sales manager; Louis Sears becomes West Texas district service manager and Albert Wagner will be parts manager in the Odessa office.

J. G. Leyh

Pitezel's former position as Oklahoma district sales manager will be filled by J. G. Leyh, who joined Franks in 1940, and who has been Franks used equipment manager. Joe S. Winter will take over as service manager for west coast operations at Compton.

Applied Mathematics Group Organizes Consulting Service

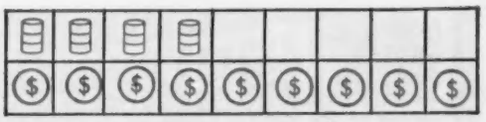
Mathematical Computing Service, consultants in applied mathematics, has been organized at 67-24 211th Street, Bayside, N. Y. The firm specializes in performing services for industries desiring engineering calculations, charts and nomographs of a complex nature and the treatment of related mathematical problems in the field of petroleum engineering.

A function of the group is the mathematical formulation and solution of a problem from given physical data. The staff consists of consultants holding doctorate degrees qualified to treat problems in applied mathematics related to the physical sciences.

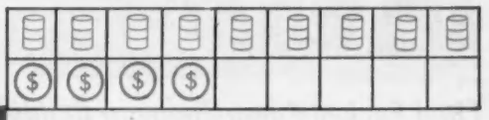
McCullough Tool Company Opens Service Location in Alberta

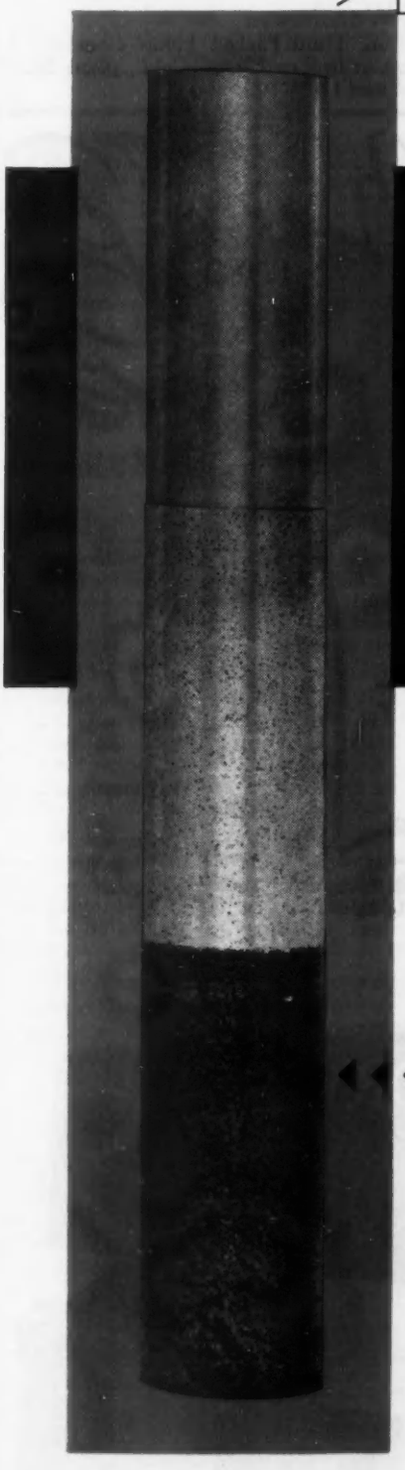
The McCullough Tool Company has opened a new service location in Drayton Valley, Alberta, Canada. This new location was established by McCullough to serve the requirements of the oil industry in the Pembina area, southwest of Edmonton.

Said to be the "World's Largest Dog House," the three section portable McCullough Tool Company warehouse measures 68 feet long, 14 feet wide and 12 feet high. Built by the Edmonton Steel Fabricators, this rugged portable warehouse can accommodate and service all McCullough equipment, and house the crews required to serve the needs of the oil industry on a 24 hour basis.



MORE PRODUCTION at LESS COST!





Pacific Pacilite (TRADE MARK)

PLUNGERS & LINERS

Used in thousands of pumps in practically every producing area and under the most severe deep oil well pumping service conditions, Pacific Pacilite liners and plungers have definitely proved their superiority. Longer liner and plunger life is assured without sticking or galling; the possibility of cracking or shearing is virtually eliminated. For further details on the Pacific Pacilite process write for Technical Bulletin #201.

The Pacific Pacilite process is a method of control etching the surfaces of pump liners and plungers to form a multitude of minute reservoirs that absorb and retain lubricants. This greatly increased lubrication allows closer fits between liners and plungers and relieves the plating tensile stress. Note dark, dull, rough finish characteristic of Pacilite processed metal. Center surface; .001" below finish; top surface: .005" below finish.

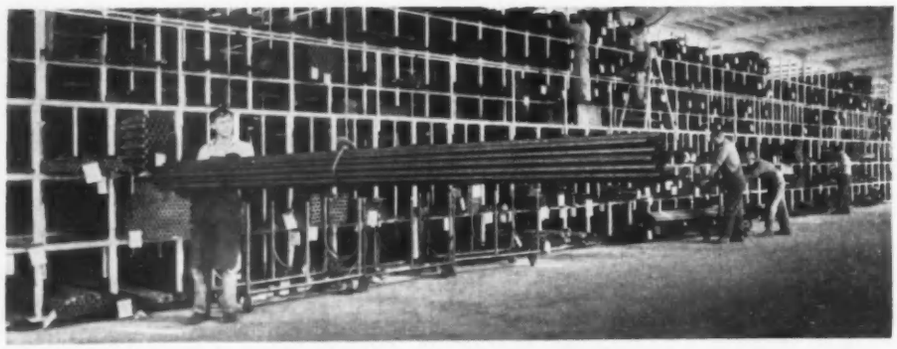
Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York—*Offices in all Principal Cities*
MID-CONTINENT DIVISION: 1221 E. 1st St., Tulsa, Oklahoma
DISTRIBUTED IN CANADA BY: Lucey Export (Canada) Ltd., 1215 9th Ave., Calgary

DW—11



Fluid Packed Pump Company Builds Warehouse

As part of its current plant expansion program, Fluid Packed Pump Company has completed a large new raw materials warehouse at its Los Nietos, Calif., plant. Shown above is part of the current stock of 1000 tons of steel tubing material.

Heads in the sand?
Not here!
Keeping "Heads up" with developments in the petroleum industry has enabled our Oil and Gas Department to render valuable service to producers and developers.
VICTORIA BANK AND TRUST CO
VICTORIA, TEXAS
A PROGRESSIVE BANK

District Sales Office Opened By Clark Bros. in Georgia

Clark Bros. Company has announced the opening of a new district sales office in Atlanta, Ga. The office will be located at 685 West Peachtree Street, N. E. in Atlanta.

Richard Foster

Opening the new Atlanta office and acting as district manager of the territory is Richard Foster. Prior to joining the staff of Clark Bros. Company in 1945, he had accumulated 16 years of experience in the turbo-machinery field. At Clark he acted as the sales manager of the Turbo-Machinery division for seven years. During the past two years Foster has been engineering sales manager for the entire Clark line of products.

Service Shop Appointments Made by Allis-Chalmers

Appointment of two new certified service shops in Texas and Washington has been announced by Allis-Chalmers general machinery division.

The American Armature Works, Houston, has been named a certified service shop for Allis-Chalmers motors and control in the company's Houston district territory. C. D. Schleyer is owner of the firm, which was established in 1946.

Picatti Brothers, Yakima, has been named a certified service shop for Allis-Chalmers motors, control and transformers in Yakima, Benton, Grant, Franklin, and Kittitas Counties in Washington.

Joseph and George Picatti are partners in Picatti Brothers, which was established in 1928 and which has been a distributor for Allis-Chalmers motors, control, pumps, transformers, and "Texrope" V-belt drive equipment since 1948.

Fisher Governor Company to Start Canadian Manufacturing Operations

Fisher Governor Company, Marshalltown, Iowa, has purchased a factory building in Woodstock, Ontario, Canada, and will start manufacturing operations there this spring.

The plant in Woodstock, constructed in 1952, is a modern one-story building with 17,250 square feet of space. Fisher diaphragm motor valves, liquid level controllers and gas regulators will be manufactured.

William J. Bestmann, who has been in charge of production scheduling in Marshalltown, is moving to Woodstock as general manager of the Canadian plant. Fisher Governor Company has Canadian sales engineering offices in Calgary, Edmonton, Vancouver, Winnipeg, Toronto and Montreal.

Brance-Krachy Appointed Reliance Sales Representative

Brance-Krachy Co., Inc., has been appointed manufacturer's representative for Reliance Electric and Engineering Company of Cleveland, Ohio. Reliance has been building electric motors and generators since 1905, and today is one of the largest manufacturers of intergral horsepower motors.

Enterprise Grants Franchise To Turkish Sales Firm

Enterprise Engine and Machinery Company, subsidiary of General Metals Corporation, San Francisco, has announced the granting of the Turkish franchise for the distribution of all Enterprise products: engines, industrial oil burners, and process machinery to Ali Kefeli, owner and manager of Kefela A. Riza Company, Istanbul.

Ali Kefeli

Ali Kefeli was at the San Francisco plant during January. Although a native of Istanbul, Kefeli was educated in Paris and obtained his bachelor of arts and mechanical engineering degrees at Stanford University, Stanford, Calif. His firm will concentrate on the municipal, industrial and marine markets in its sales of engines.

National Tube Begins Program To Increase Pipe Production

A two-fold program to increase production of oil country tubular products and to meet future requirements of the oil industry has been announced by National Tube Division of United States Steel Corporation.

Work on facilities designed to triple the division's production of deep-well casing at National Works in McKeesport, Penn., has begun. This pipe, a 110,000 pound minimum-yield strength casing, is being used in increasingly large proportions in the oil industry. Additional equipment will be installed for treating and finishing the pipe in the seamless pipe mills.

Work has also begun at National Tube's Lorain Works in Lorain, Ohio, on the addition of new upsetting units to increase production of external upset API tubing in the 2⅜ to 4½-inch O.D. range.

Atlas Powder Company Moves to New Building

Atlas Powder Company has moved its general offices from the downtown Delaware Trust Building to a new building on a 45-acre tract about three miles from downtown Wilmington.

The new building will provide additional space as well as the most up-to-date facilities for the office staff.

Harries Sales & Rental Represents Goodall Rubber

Harries Sales & Rental Company has been appointed to represent Goodall Rubber Company of Texas in the Permian Basin area. W. A. (Bill) Harries is president of Harries Sales and Rental.

Harries, a graduate of Oklahoma University, worked for Reed Roller Bit Company in Oklahoma City for nine years, joining The National Supply Company in 1945. He formed his own company in August, 1954 with headquarters in Odessa.

Use the Readers' Service blue post cards on the last page of this issue for more information on advertised products.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All classified ads payable in advance. COPY DEADLINE: 17th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

GASOLINE PLANT
FOR SALE

Gasoline Plant, located in Brazoria County, Texas, shut down in January, 1954. Had been processing approximately thirty-three million feet of gas daily with absorber pressure approximately six hundred thirty pounds. Plant recovered Propane, Butane, Gasoline, Kerosene and Diesel Oil. Detailed inventory available upon request.

SOUTHERN PRODUCTION CO., INC.
P. O. Box 670, Ft. Worth, Texas

KENTUCKY
BLUE GRASS FARM
FOR SALE

Beautiful, square shaped, 616 acres, gently rolling, Blue Grass farm, located in racehorse country, 5 miles from Paris, Kentucky, and 18 miles from Lexington, Kentucky, the heart of the famous Blue Grass section.

Fronts on a main thoroughfare (US 227), bounded on two other sides by a black top county road. Year round water supply from Green Creek, running through middle of farm, fed by several never failing springs.

Rich, fertile, soil, very high in phosphate from underlying phosphoric limestone, producing excellent Burley tobacco, 1954 base of 21.5 acres. Ideal farm for all livestock—especially racehorses.

For further information contact owner, James C. Stone, Jr., either directly or through an agent, at 1218 Heyburn Building, Louisville 2, Kentucky. Telephone Clay 6336.

■ Complete Widco, two curve, electrical logging unit. Six thousand foot depth, hydraulic drive, mounted in one-ton G.M.C. panel. Like new, fully equipped with all accessories, ready for immediate field operation. Box 59-W, c/o WORLD OIL, Houston, Texas.

GOOD #1 GRADE USED 8" LINE PIPE
FOR LESS!
Save almost ½ the cost of new pipe.

Lapweld 8⅝" O.D. 28.55 used pipe. Straight single random lengths. Machine cleaned. Plain and bevelled or screw end. 850 to 900 PSI. Pipe located in Illinois. Will sell for cash, or will finance meritorious propositions.

REDNEB PIPE CO.
P. O. Box 1798, Shreveport, La.
Phone 2-3276

■ WE BUY, WE SELL spudders, rotaries, core drills, tools in all areas. If you want to buy or sell, contact. PRESSEY & SON, Pueblo, Colo.

FOR SALE

■ 1 Lot of SEDIMENT STRAINERS, NEW with monel screens. 49-4" 300 Series steel, weld type; 5-4" 300 Series steel, flange type. Ratio, Screen to Pipe: 5.5:1. Make offer. J. L. Pinkerton, Inc., 1099 E. Wardlow Rd., Long Beach 7, Calif.

■ Ford field service truck. Electric welder, lathes, taps, drills, dies, rods, tools, light plant, complete, reasonable. Tip Johnson, 607 W. Mayfield, San Antonio, Texas.

BUSINESS OPPORTUNITIES

Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

MAKIN DRILLING COMPANY
P. O. Box 1628 — **146 Allen Building**
Hobbs, New Mexico — **Midland, Texas**
Phone 3-3141 — **Phone 2-2962**

POSITIONS WANTED

■ Experienced Driller, presently employed in drilling operations in Southwestern Ontario, owner of 46 Cyclone rig desires partnership with owner of rotary rig—object drilling and prospecting Southwestern Ontario. Paul Palenkas, West Lorne, Ontario.

HELP WANTED

■ Petroleum Engineer with Master's Degree, or Doctor's in Chemical, Mechanical, or Petroleum Engineering, for research and teaching in Reservoir Mechanics and related fields at rapidly growing southwestern institution. Rank and salary open, twelve months employment possible, consulting work encouraged and available in immediate area. Applications will be kept confidential. Box 53-W, c/o WORLD OIL, Houston, Texas.

■ Engineer for well Established Manufacturer. Experienced engineer for design and development of oil emulsion treating equipment, gas dehydrators, stabilizers, desulphuring units and other oil and gas well production equipment. Must be capable of taking complete charge of projects. All replies confidential. Reply: Chief Engineer, Union Tank & Supply Company, P. O. Box 2092, Houston, Texas.

GEOLOGICAL SERVICE

■ Will conduct a limited number of free underground oil surveys to test new invention. Herman Bernau, Ogden, Iowa.

MISCELLANEOUS

■ Printed forms for Office and Field—these stock forms are now used by oil companies, contractors and independent operators throughout the oil industry. Printed in large quantities—available for immediate shipment in any desired quantity when, where, as needed. Faster delivery and more economical. Write for free copy of "Oil Company Stock Forms" catalog giving illustrations and prices on more than 50 different available forms. Stock Form Dept., Gulf Publishing Company, P. O. Box 2608, Houston, Texas.

■ Production Wanted. Working interests or royalty interests. Send complete information, engineer's estimates on production if available. Give complete story in first mailing. Pincipals only. Box 58-W, c/o WORLD OIL, Houston, Texas.

The facts are . . .

Series "80"

TUBING BLOCKS

add up to . . .

★ More weight, greater capacity—free, true falls. J-M "Klipper" Grease Seals on all Sheave bearings.

★ Larger range of sheave SIZES, 17"-20"-24". Less friction loss, roller bearing sheaves, roller thrust bearing block.

McKISSICK

McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

SQUEAKS from the BULLWHEEL

"Where yuh going . . . to a gusher?"

The Hand Is Quicker

A man was reading a prepared address to a meeting of industrialists and he swung into his speech.

"The average businessman is tired. He has worked long and diligently in difficult times and he is weary. He is physically and mentally exhausted. But he isn't nearly as tired as the girls who have to type all this hogwash."

There came a long tense pause while a delighted audience began to yelp its appreciation. The speaker stared at his script in disbelief. "Why," he blurted at last, "I never wrote anything like that!"

Tongue Twister

A woman rushed wildly into the station with her half-grown son. Her train was about to depart and she wanted two tickets to Duluth. When she reached the window she was very much out of breath, but managed to gasp: "Toodle do looth!"

The ticket man grinned and replied: "Tra la, Tra la!"

Psychology

Mother (to finicky child at table): "Eat it, dear—pretend it's mud."

Good Old Days

"Papa," said the doting mother, "Robert's teacher says he ought to have an encyclopedia."

"Encyclopedia, my eye," grumbled the father. "Let him walk to school like I did."

Higher Education

Three young college graduates had just completed an examination for a job in General Electric's research department. They emerged from the quiz looking as though they'd been through a wringer...

First Grad: "Wow! I was summa cum laude at Texas U, but the stuff they threw at me in nuclear physics really knocked me for a loop!"

Second Grad: "Well, I was among the first ten at Rice, and you know they have one of the best scientific schools in the country. But those questions in differential and integral calculus! Jeez!"

Third Grad: "Well, I wasn't a cum laude, or whatever you call it, but I am a graduate of Oklahoma University—and what's this 'long division'?"

Quick Thinker

One of the home office reps called on a distributor in West Texas, who showed him around the country, stretching the the truth whenever necessary, as any loyal Texan will. It was a blistering hot day and they were crossing a particularly desolate mesquite-covered stretch of wasteland, when a long-legged road-runner broke cover and crossed in front of them. The rep started at the strange looking thing in amazement and asked what on earth it was.

"That," said the Texan, impressively, "is a Bird of Paradise."

The rep looked around at the rock and dust and shimmering heat, started solemnly at his guide.

"My friend," he said, "I've never seen NO-body that was farther from home!"

On Schedule

Sign in a western bar: "We don't have TV, but we do have a fight every night."

Up to the Minute

Woman: "What's your cat's name, little boy?"

Boy: "Ben Hur."

Woman: "That's a funny name for a cat. How did you happen to pick up such a name for it?"

Boy: "Well, we just called him Ben until he had kittens."

L HOTELS

FREE PARKING
COMPLETELY
AIR-CONDITIONED

The small hotels with the big welcome

IN DALLAS

LAKEWOOD HOTEL
1818 Abrams Rd.

LOMA ALTO HOTEL
4518 Lemmon Ave.

LAWN HOTEL
3718 Lemmon Ave.

LYNN HOTEL
3405 Gaston Ave.

In GRAND PRAIRIE
Lennox Hotel
N.W. 2nd & Main Sts.

In FORT WORTH
Loring Hotel
Camp Bowie Blvd. & University Dr.

Come as you are . . . . . .

Stubborn Fish?

Why fight them? Call McCullough for the –

JET CASING CUTTER

(TO CUT STUCK CASING INSTANTLY)

or the **BOTTOM HOLE JET CUTTER**

(TO BREAK-UP OR SIDE TRACK BOTTOM HOLE JUNK)

Write for Bulletin No. 601 and Bulletin No. 701

McCullough

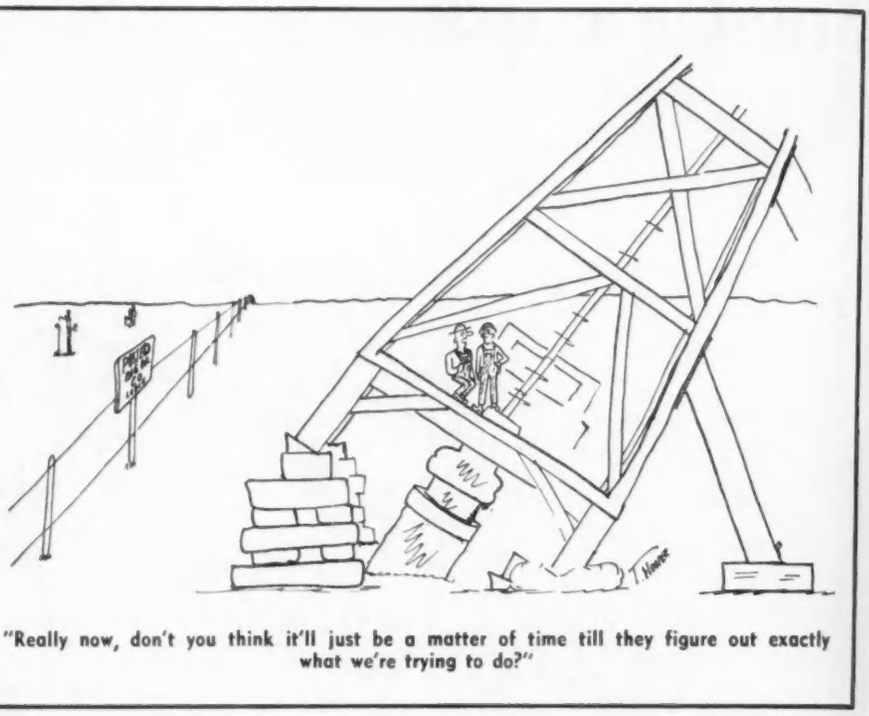
TOOL COMPANY

LOS ANGELES • HOUSTON • EDMONTON

OVER 50 BRANCH OFFICES

SERVICE ANYWHERE – ANYTIME

SECONDARY RECOVERY
CABLE ENGINEERING
TECHNICAL CONSULTING PRODUCTION ENGINEERING SERVICE, INCLUDING CORE ANALYSIS
PRESSURE MAINTENANCE WITH GAS OR WATER
REPRESSURING WITH GAS OR WATER
YOU WERE RIGHT, DUDLEY -- IF THERE'S ANY OIL LEFT CABLE ENGINEERING WILL GET IT OUT.
SURVEYS
ESTIMATES
DESIGN
INSTALLATION
SUPERVISION
PETROLEUM ENGINEERS
CABLE ENGINEERING
WICHITA FALLS, TEXAS



"Really now, don't you think it'll just be a matter of time till they figure out exactly what we're trying to do?"

Sensitive

"Why did you stop singing in the choir, Thomas?"

"Well, one Sunday I was sick, and didn't sing, and a lot of people in the congregation asked if the organ had been fixed."

Persistent

A drunk in a hotel repeatedly called the phone operator in the early a.m. as to when the bar opened. Each time she said "11:00."

Finally, the manager was asked to take the call and he said "11:00, but I'm going to be there to see that you don't get in."

Whereupon the drunk replied, "I don't want in. I want out."

Sound Reasoning

A man handed the manager of the telephone company a bouquet of flowers and said, "It's for the phone girls."

Obviously pleased, the manager said, "Thank you, sir, thank you. I know they will appreciate the compliment."

"Compliment!" roared the man. "I thought they had all died."

Correction

One oil man to another: "Hear you brought in a dry hole last week."

Second Oil Man: "Please. Let's just say I brought in a long, thin swimming pool."

Haven't We Met?

A well-known businessman, shopping for a parrot to present to his wife on her birthday, found a feathered specimen that exactly suited his fancy. However, the clerk tried to discourage his choice by explaining that this particular parrot came from a house of questionable repute.

Seeing nothing particularly derogatory about that, the businessman persisted in his choice and, on the evening of his wife's birthday, when all the guests had arrived for a party in her honor, he proudly produced the fine parrot and uncovered his cage.

The parrot took a look around, blinked his eyes, and then remarked: "Hmmm—new girls, but the same old customers. Hiya, Joe."

Here it is . . . . . .

ROACH *Heavy-Duty* TIMERS

★ DEPENDABLY ACCURATE
★ JEWELED MOVEMENT
★ HEAVY-DUTY MERCURY SWITCH
★ HEAVY-DUTY WEATHER-TIGHT CASE
★ COMPACT INSTALLATION
★ ONE-KNOB OPERATION

Write for our new bulletin #101

ROACH
EQUIPMENT CO.
801 W. 23 ST. . . . TULSA, OKLA.
P. O. BOX 1067 . . . DIAL 5-1259

BAKELITE VALVE DISCS

. . . to maintain maximum capacity!

Here are Discs that are strong, dense, light and resistant to the corrosive action of many chemicals.

FRANCE MAKES THEM!

Write for Complete Information

FRANCE PACKING COMPANY

9927 Bustleton Ave., Philadelphia 15, Pa.

More News

from TUBE-KOTE — world's largest applicators of plastic linings for oil field pipe!

Home of TK-2 plastic linings — now in service in more than 12,000,000 feet of oil field pipe.

New

facilities at Tube-Kote boost pipe lining capacity to 10,000 feet per day!

Big things are happening out at Tube-Kote's 15-acre plant in Houston. New equipment being installed in new buildings . . . new automatic spray guns . . . new electrically-controlled bake ovens . . . more capacity to provide faster service supplying the finest type of plastic linings for pipe and other tubular goods.

Plus the new plastic coating facilities, there's a big quantity price discount that will cut your pipe lining cost!

So, the good news at Tube-Kote is that you can have your pipe lined with TK-2 plastic — *a special corrosion-resistant formula exclusive with Tube-Kote* — days faster, and for less money than ever before!

New

quantity price discounts apply on all pipe lined with TK-2 plastic!

Mail coupon today for details about TK-2 plastic linings and the new price discount.

TUBE-KOTE T. M. REG.

TUBE-KOTE, INC.
P. O. BOX 20037 • HOUSTON 25, TEXAS

Pioneers in plastics since 1939 . . . manufacturers-extruders of plastic pipe for the oil industry. Factory trained, field engineers available for consultation in all principal oil areas.

TUBE-KOTE, INC.
P. O. Box 20037
HOUSTON 25, TEXAS

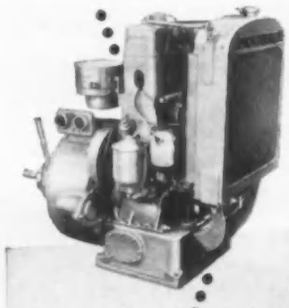
Please send me information about TK-2 plastic linings and your recent price discount.

☐ Also send me information about your plastic pipe.

Name_____

Firm_____ Title_____

Address_____ City_____ State_____



keep production

on schedule . . .

. . . with

NORDBERG POWER CHIEF

GAS ENGINES

Here's the low cost answer to compact, dependable power for 'round-the-clock production pumping—the new Nordberg *POWER CHIEF* Gas Engine. Backed by many years of service to the petroleum industry, this Nordberg engine is ruggedly built to keep production on schedule day-in and day-out, even under the most severe operating conditions.

Available as straight power units, rated 18 hp max., with stub shaft or clutch power take-off . . . and as "packaged" generator sets producing up to 10 kw, Nordberg *POWER CHIEF* Gas Engines are simple to install and easy to maintain—always ready and able to serve you 24 hours a day.

Make sure you have the specifications of the Nordberg *POWER CHIEF* engine in your reference file. Copies are available upon request.

Nordberg Mfg. Co., Milwaukee, Wisconsin

NORDBERG

Builders of America's Largest Line of Heavy Duty Engines . . . from 10 to over 10,000 horsepower

SEE YOUR NEAREST NORDBERG DISTRIBUTOR:

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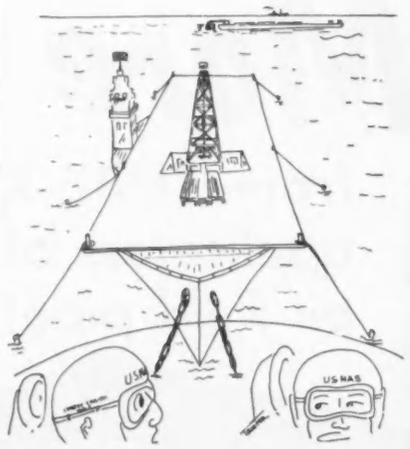

"The Admiral said he'd make the old CVE pay its own way."

Trapped

Angry Wife: "Homer, one of the pheasants you were shooting yesterday called and left her number."

Not Much

A man was strolling along a dimly lighted street when a stranger slipped from the shadows. "What do you want?" asked the stroller nervously.

"Would you be so kind," said the voice plaintively, "as to help a poor unfortunate fellow who is hungry and out of work? All I have in the world is this gun."

Definition

Opera is where a man is stabbed in the back and instead of bleeding, he sings.

Proper Diet

They say that mixed greens are good for one. Agreed—especially when they're tens and twenties.

They Learn Early

A bad tempered driver was always cussing out other drivers, even in front of his five-year-old daughter.

One Sunday, Mama took the moppet for her ride, leaving Daddy home. When they got back, the infant said: "We had a wonderful ride, Daddy. We saw cows and chickens and pigs and little lambs. And, you know what? We didn't see a single bastard!"

Matter of Opinion

Driver, doing eighty: "It's great to be speeding along like this. Don't you feel glad you're alive?"

Nervous Passenger: "Amazed is the word I would have used."

City Life

An old man from the hill country took his first trip to a large city. Walking into one of the skyscrapers he saw a doorman standing by a special kind of a door. An old lady stepped in, a light flashed red and she was gone. A moment later the elevator descended, the door opened and out stepped a beautiful young girl.

"Begorra," said the old man, blinking his eyes, "I should have brought the old woman with me."

from the new CF&I SEAMLESS TUBE MILL

headin' for the oil country

Prompt and efficient service for the oil and gas industries of the Rocky Mountain and Southwest areas. That's the need that brought into being the new CF&I Seamless Tube Mill at Pueblo, Colorado—newest mill of its type located West of the Mississippi.

Here—centrally located to some of the largest oil and gas producing regions—the most modern facilities and machinery combine with step-by-step quality control to assure seamless casing and tubing that for precision and quality are unrivaled in the industry.

CF&I Seamless Oil Country Casing and Tubing meet API STD 5A specification—in sizes from 2⅜" O.D. through 9⅝" O.D.

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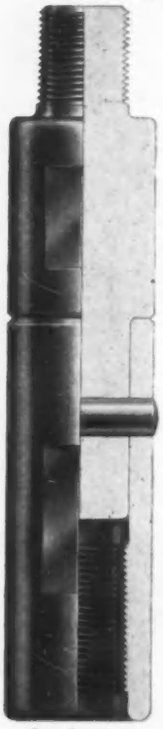
WOOLSEY ROD SAFETY JOINT



Pat. Pending

Saves Time—
Saves Worry
Saves Money!

•

Woolsey Rod Safety Joints are furnished in 9000# shear in ⅝" size, and 14,000# shear in ¾" size. Other shear strengths are available on special order. They should generally be run 3 or 4 rods above the pump. If the pump is stuck and cannot be worked loose, simply pull up weight of rods plus rated shear strength, or a little above, and the pin will snap. For instance, if the rods weigh 6000#, the ⅝" joint will shear at 15,000# or a little above.

See our pages in Composite Catalog

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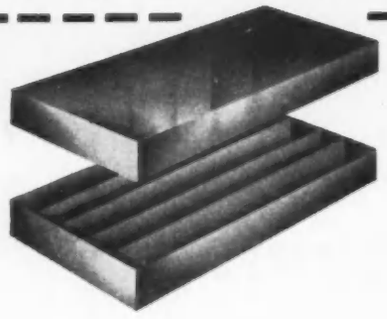
P. O. Box 901 Houston, Texas

CORE BOXES



Each box holds 10 feet of core, and has following copy on end:
Hole_____ From_____
To_____ Box No._____
"Project Name" printed on top and bottom of box.

Size	Length		Width		Depth
AX CORE BOX	24	x	8¼	x	1⅜
BX CORE BOX	24	x	9½	x	1¾
EX CORE BOX	24	x	7	x	1⅛
NX CORE BOX	24	x	12	x	2¼
SPECIAL 2½" CORE BOX	24	x	13⅞	x	2⅝
SPECIAL ANY SIZE					

Samples available on request. Small shipments made immediately as we carry small stock of all sizes at all times. Write for catalog sheet.

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New Books, Maps and Movies

MINERALS IN WORLD INDUSTRY, Walter H. Voskuil, McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. $5.75.

The author, chief mineral economist, Illinois State Geological Survey, and professor of Mineral Economics, College of Engineering, University of Illinois, presents the latest facts about the location of minerals throughout the world and the part they play in economic production, in national and international economy.

Iron, the ferroalloys, and important nonferrous metals, copper, lead, zinc, aluminum and magnesium are each discussed in detail. The hydrocarbons, oil and gas, are also considered because of their unique contribution to transportation and agriculture and their significant position in the present struggle for military power.

One chapter covers the use of plant-food minerals, another discusses the principal building materials and the function of structure under today's industrial conditions. The two concluding chapters deal with minerals in world affairs, the interests and problems of the United States and the mineral requirements and resources of other major nations.

•

STUDY IN POWER, JOHN D. ROCKEFELLER, INDUSTRIALIST AND PHILANTHROPIST, Allan Nevins, Volumes 1 and 2, Charles Scribner's Sons, New York-London, 1953.

Nevins has written a complete biography of Rockefeller as a business giant, as the world's greatest philanthropist, and as a man. This book is not only the story of Standard Oil, of the University of Chicago, of the Rockefeller Foundation and Medical Institute, it is also the story of the period in American history during which the bases of our economic greatness were laid. A vast store of material, hitherto unavailable, in the form of letters and business papers, placed at the author's disposal illustrate and illuminate the business history of Rockefeller and Standard Oil from 1870 to 1896.

•

INDUSTRIAL MEDICINE AND THE COMPANY RELATIONS PROGRAM, R. B. O'Connor, M.D., Research Division, California Personnel Management Association, Fifth Floor, Farm Credit Building, 2180 Milvia Street, Berkeley 4, Calif.

This publication is a stenographic brief of an address given before The California Personnel Management Association by the medical director, Loss Prevention Department, Liberty Mutual Insurance Company. Dr. O'Connor describes the role that a good industrial medical department can play in industrial relations in plants and its contribution to the productiveness of the workers.

•

GEOLOGY OF WEBSTER PARISH, Bulletin No. 29, James L. Martin, Leo W. Hough, David L. Raggio, and Adolph E. Sandberg, Department of Conservation, Louisiana Geological Survey, Baton Rouge, La., November, 1954. $1.

In the years following 1943, considerable petroleum activity has taken place in Webster Parish; several old fields have been extended laterally and vertically and new oil and gas fields have been discovered. Deep wells drilled in the area have penetrated older formations of Permian and Jurassic age. These developments have revealed geological information important to the areas in north Louisiana, south Arkansas, and northeast Texas surrounding Webster Parish as well as the parish itself. It was deemed advisable in 1951 to revise and bring up to date the Webster Parish report and publish it as a geological bulletin. Physiography, stratigraphy, structure, salt domes, and economic geology are among the topics covered. The book is well illustrated with separate maps.

•

SUMMARY OF WATER FLOOD OPERATIONS IN ILLINOIS OIL POOLS DURING 1953, Interstate Oil Compact Commission, P.O. Box 3127, Oklahoma City, Okla.

This pamphlet supplements four previously issued reports of water flood operations in Illinois. The pamphlet is a joint project of the Illinois Secondary Recovery and Pressure Maintenance Committee, the Illinois Geological Survey and the Secondary Recovery Division of the IOCC.

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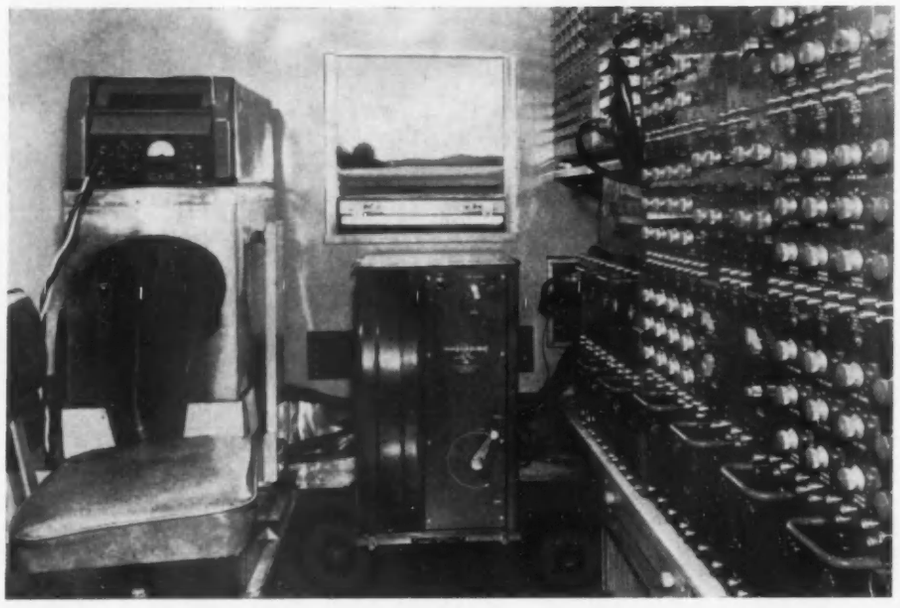


Magnetic Disc Recorder

Production of the first seismic magnetic recorder using a disc as recording medium has been announced by Houston Technical Laboratories. Use of this MagneDISC system makes possible the recording of up to 96 data channels on one plastic disc, avoiding playback discontinuities, time consuming loading operation, data limitations and other restrictions.

Because recording is done in one complete revolution of the disc (5½ seconds), the shot may be fired at any time, thus eliminating recorder starting problems. There is no problem of tape threading, and immediate playback through a recording oscillograph is possible. The records can be stored safely for long periods of time.

The MagneDISC system consists of a compact drive unit, with frequency modulators, demodulators and test circuitry in a separate case. Weight of the system, including power supply, is 282 pounds.

Equipped with magnetic recording heads for 48 seismic channels and 12 auxiliary channels, the standard model can record four 24-trace shots per disc. The recorder can also be supplied with 96 recording heads, plus 19 auxiliary heads, grouped to record six 16-trace shots, two 48-trace shots, or one 96-trace shot. The disc is driven by a fork controlled dc motor to which it is gear coupled.

The MagneDISC has a signal-to-noise ratio of 46 decibels where peak output signal is measured at three-fourths of 1 percent distortion and noise is the measured peak value. Frequency response is ±3 db from 10 to 300 cycles per second. Base timing accuracy is ±0.5 millisecond between traces with a timing signal accuracy of one part in 10,000. The measured harmonic distortion is three-fourths of 1 percent. Recording time is 5 seconds after the time break. Demodulator output is 70 millivolts rms at 2.2K ohms and 3 millivolts at 100 ohms for 0.25 volts input at 250K ohms.

The MagneDISC can be purchased or leased from HTL.

For more data circle **No. E1** on Readers' Service Card, last page this issue.

Cyclone Muffler

The development of the Yale cyclone muffler, designed to capture carbon particles from the exhaust gases has been announced by The Yale & Towne Manufacturing Company. Centrifugal action is employed to throw solid particles into a collector leaving only the gases free for exhaust. When installed on gas or diesel powered trucks, the Yale cyclone muffler reduces the possibility of ignited exhaust particles as a source of ignition to combustible material.

As diesel engines have a tendency to discharge hot carbon particles, the cyclone muffler has been made standard equipment on all Yale diesel powered trucks. Although the gas engine is less likely to discharge hot solid material, the Yale cyclone muffler has also been made available at slight additional cost with this type of power for those locations where a greater fire hazard is present.

For more data circle **No. E2** on Readers' Service Card, last page this issue.

Portable Rigs

Exploration Equipment Company's special portable rig, the Model 50 can be used for seismographic exploration for depths under 100 feet. It is provided with a special cat haul to permit power lifting of Kelly tools and drill pipes. It is powered by a K160 engine manufactured by Kohler Company Kohler, Wis.

The heaviest piece of equipment on the rig weighs 85 pounds.

Model 100 drill is designed for drilling operations in seismographic exploration up to 200 feet. Powered by a Kohler K-660 engine, it is available on trailers, boats and barges for exploration in all types of terrains.

For more data circle **No. E3** on Readers' Service Card, last page this issue.

Comparison Bridge

Southwestern Industrial Electronics Company announces a new model of the Comparison Bridge, to be designated the E-2.

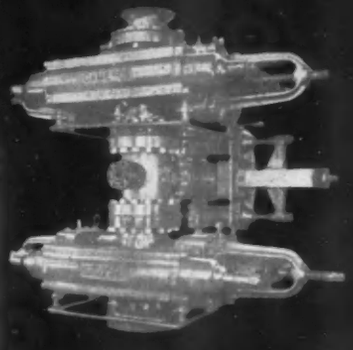
The instrument can now be operated by an optional foot switch as well as by the conventional push button. Improved stability, accuracy and sensitivity enable resistors, capacitors and inductors to be compared over a range of 1 ohm to 5 megohms at 60 cycles. Differences as small as 1 percent may be measured on the 1 percent full scale meter range. Other scale ranges of 2½, 5, 10 and 25 percent are also provided.

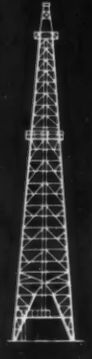
In addition to its use as a comparator and go-no-go gage, the E-2 may be combined with a decade box to make quick and accurate measurements of absolute values.

For more data circle **No. E4** on Readers' Service Card, last page this issue.

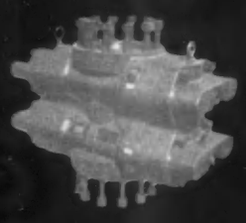
Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

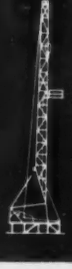
● QRC Preventers and HCR Flowline Valves for high substructure rigs.





● SS Preventers for portable type rigs having low substructures.





Blowouts still happen . . . as witnessed above . . . even on the best regulated rigs, but Cameron Drilling Control Equipment, in the hands of safety-conscious operators, has gone a long way toward eliminating blowouts. As drilling depths have increased, so have well pressures, and the need for more dependable pressure control equipment. Constant research and improvement in this field has enabled Cameron not only to keep abreast but to keep ahead of the industry's needs.

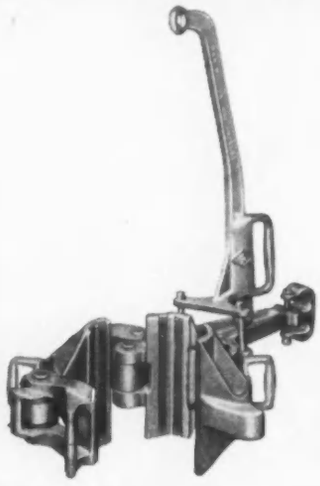
Cameron

IRON WORKS, INC.

P. O. Box 1212, Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: British Oilfield Equipment Co., Ltd., Time & Life Bldg., New Bond Street, London W. 1 England.

DRILLING



Drill Tubing Tong

For use in handling drill tubing in slim hole programs, Web Wilson Oil Tools, Inc. has developed the Type BDF tubing tong, which does not crimp, deform or bottleneck drill tubing. Although designed specifically for drill tubing, this new tong also operates on regular tubing and small diameter casing. Each of the four die slots contains two Web Wilson 5¾-inch tong dies, making a total of eight dies with 46 inches of pipe-contacting surface by the dies. This large area of die contact, combined with other features of the tong design, makes possible a uniform grip which avoids crimping even when used on thin-wall light weight tubing.

(This item supplements Web Wilson Oil Tools, Inc. data on pages 5165-5192 of the Composite Catalog, 20th Edition.)

For more data circle **No. E5** on Readers' Service Card, last page this issue.

Jet Perforating Gun

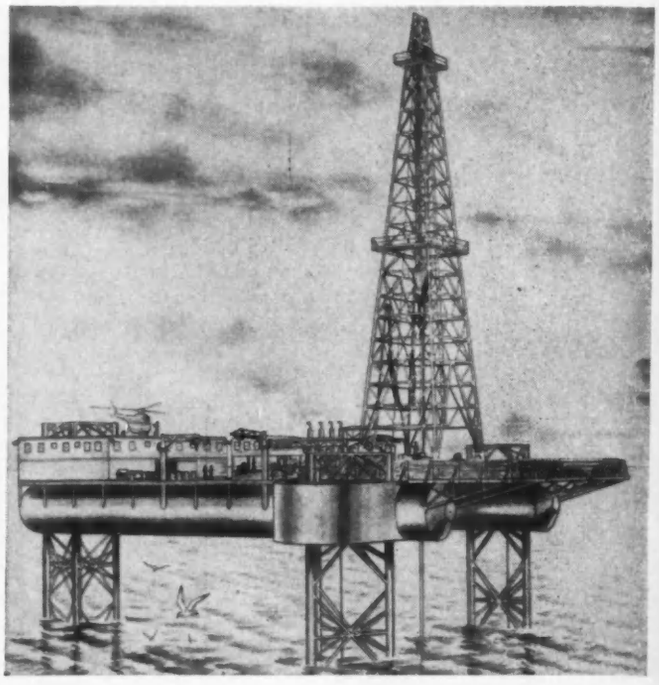
A newly-engineered four-inch jet perforating gun has been introduced by The Western Company of Midland, Texas. The Western Rocket jet gun involves a new principle in positioning the jet charges within the gun. The new positioning provides a more effective utilization of the jet force, and also shortens the length of the prima cord between charges which permits the use of a larger jet charge than has been the standard in four-inch jet guns.

Tests fired in standard targets of 20 pound 5½-inch casing and 72-hour neat cement show increases in the size of the entry hole, penetration and hole volume. The entry hole is approximately .45 caliber in size compared with a .30 caliber hole made by the standard four-inch jet gun. Penetration is increased from 8 percent to 10 percent over that of the standard jet gun, and hole volume is increased as much as 81 percent. The deeper hole provided by the Western rocket will cause less restriction to flow, thus providing easier access to the formation for high viscosity fluids used in fracturing or for fluids used in high injection rate treatments, both fracturing and acidizing.

For more data circle **No. E6** on Readers' Service Card, last page this issue.

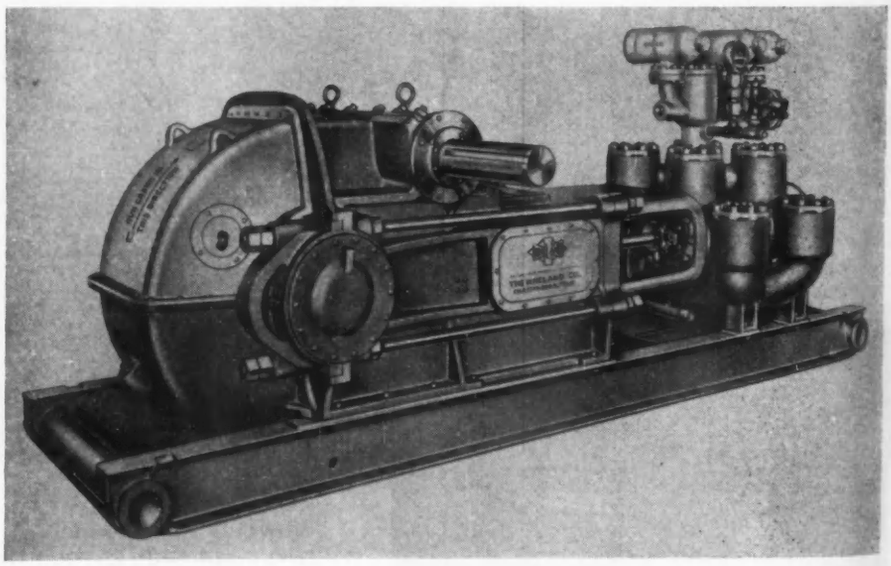
Drilling Platform

A sea-going, oil-drilling platform more than half the size of a football field—one that will ride up and down on stilts 12 stories high—is under construction by R. G. LeTourneau, Inc.



The two million dollar self-elevating platform is being constructed for Zapata Petroleum Company of Midland, Texas, and is scheduled for completion this summer. Part of the fabricated assemblies and components are being manufactured at Longview and will be assembled at LeTourneau's Vicksburg plant on the Mississippi River. After launching, the 8 million pound steel platform will be floated more than 400 miles down the Mississippi to the Gulf of Mexico and towed to a drilling site. At the site, the towering spuds will be driven to the ocean bottom by electric motors and the platform will climb the spuds until the deck is the desired height above the waves. After a well have been completed, the platform will lower itself to the water again, raise the spuds from the ocean floor and be towed to a new drilling site.

For more data circle **No. E7** on Readers' Service Card, last page this issue.



Power Slush Pump

The Wheland Company has announced its new 750 horsepower 7¾-inch by 18-inch duplex power slush pump HP-18000. The newest addition is designed for profitable use on medium as well as deep wells. It is light enough to be moved in one piece as a complete unit and strong enough for tough jobs. The pump has a low center of gravity, overall dimensions within load limits and base construction to permit easy loading and skidding.

The new pump is built to deliver sufficent volume and pressure to drill from the surface down to 20,000 feet without needing another pump connected in parallel or compounded. It delivers volume and pressure that permit the use of any type of jet, conventional or core bit in any formation.

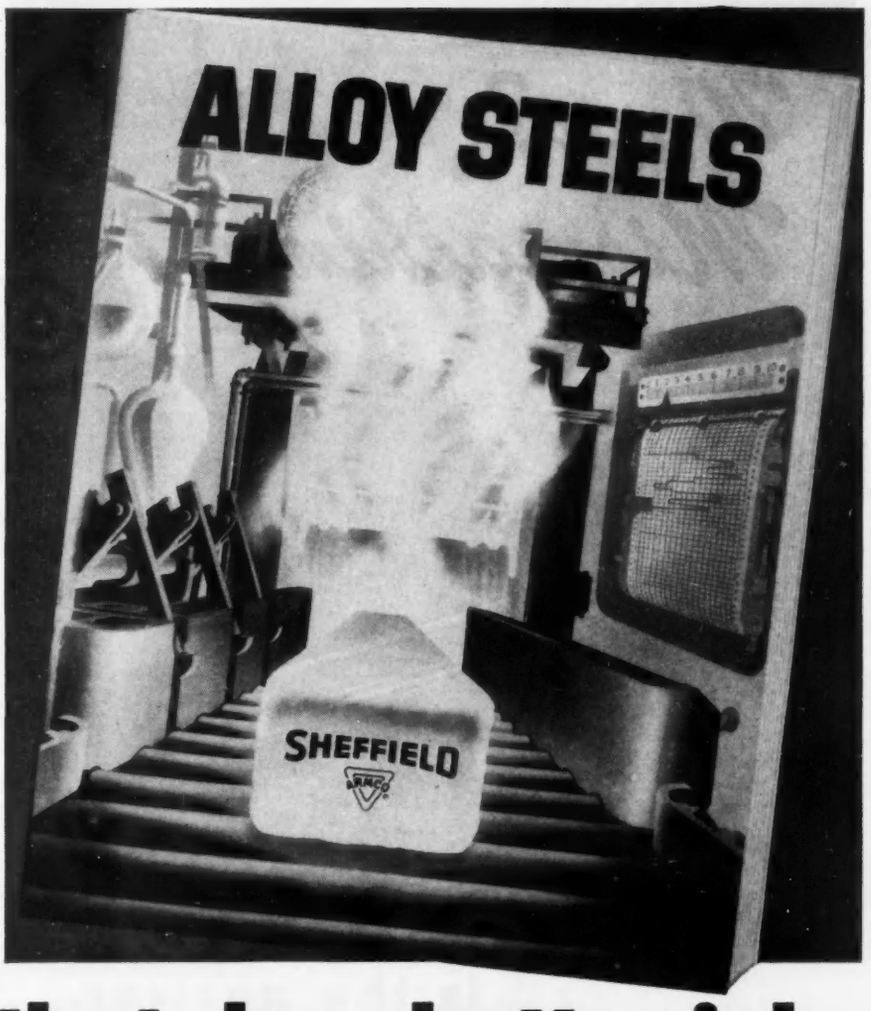
The HP-18000 pump has been field tested. On its first 12,500 foot well, it was not necessary to remove a pot cover. Up-to-date field records will be submitted to interested contractors.

(This item supplements The Wheland Company data on pages 5145-5164 and Page 3087 of the Composite Catalog, 20th Edition.)

For more data circle **No. E8** on Readers' Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

This new book helps manufacturers give users better values in . . .



products that do a better job

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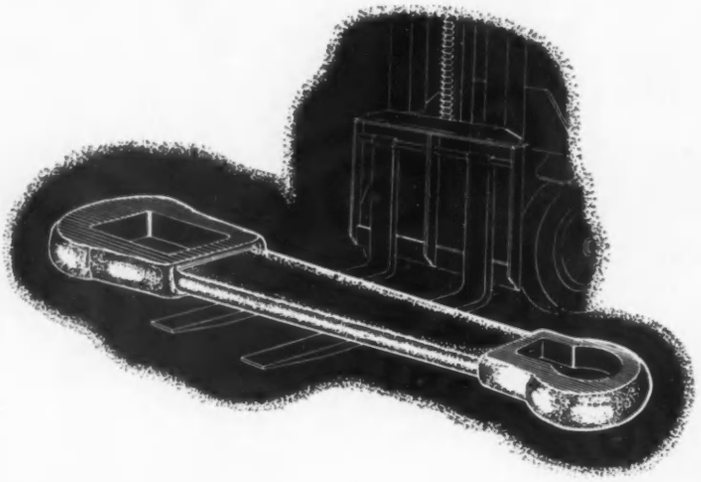

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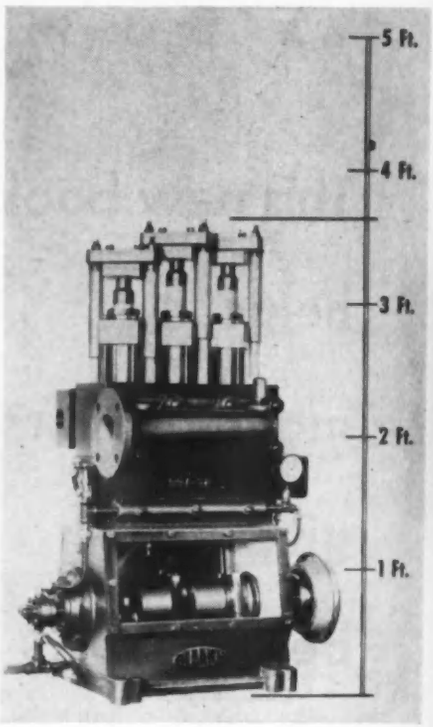
PRODUCTION



Direct Flow Pump

A pump offering advantages and economies in a wide variety of industrial applications has been developed by The Aldrich Pump Company. This new unit is a 2½-inch stroke, 25 horsepower direct flow triplex pump. Because of its relatively small size, "Powr-Pac" offers economies to users who previously have been forced to buy pumps larger than actually needed.

One feature is the sectionalized fluid-end design. Individual fluid-end sections are easily replaced at a fraction of the cost of the entire fluid-end. Working barrel can be furnished in carbon steel, aluminum bronze, stainless steel or Hastelloy. Plungers are made of heat-treated carbon steel, stainless steel, solid porcelain or bronze. Valve seats are available in aluminum bronze, stainless or hard faced steel and valves are available in aluminum bronze, Insurok, stainless steel or nylon.

The pump is precision-machined throughout. Crankshaft is of high grade carbon steel; the frame is a semi-steel casting with power-end moving parts totally enclosed; and connecting rods are drop forged with babbitt-lined, precision crankpin bearings.

In sizes the "Powr-Pac" is available in plunger diameters from 2½ inches to 11/32 inch, for pressures from 390 pounds per square inch to 20,700 psi with displacement from 109.6 gallons per minute to 2.08 gpm. This new pump suggests applications in many operations, including descaling, die casting, roll balancing, water-flooding, press operation, hydraulic testing and chemical processing.

(This item supplements The Aldrich Pump Company data on Pages 174-175 of the Composite Catalog, 20th Edition.)

For more data circle **No. E9** on Readers' Service Card, last page this issue.

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Adair Service Co. - - - - WE-6497, HU 6-3462
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Luccous - - - - - - - - - - - - 4-8471, 4-4320
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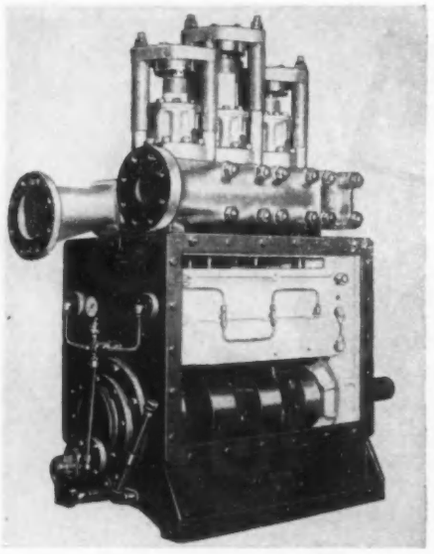

High Volume Pumps

A new series of high pressure, high volume pumps for oil recovery and industrial service has been introduced by Ajax Iron Works. Featuring a vertical triplex design with a five-inch stroke, the Series TP-5000 pumps are available in 11 plunger sizes with a maximum capacity of 8850 barrels per day.

The vertical construction offers more hydraulic power per square inch of floor space; accessibility of sectionalized fluid end for ease in maintenance; and reduced wear on packings, crossheads, crosshead guides, plungers and bushings.

Design features include solid ceramic plungers; double roller main bearings; streamlined discharge manifold; self-adjusting packing; and 100 percent pressure lubrication to crosshead guides, crosshead pin bearings and crank pin bearings. Corrosion-resistant materials can be supplied at the user's specification.

Ajax vertical triplex pressure pumps run continuously in maintaining hydraulic pressures in fluid injection for oil recovery. They also are recommended by the manufacturer for applications such as central hydraulic power systems; descaling steel; roll balancing; cleaning condenser tubes and open hearth chequers; handling brines, wastes, solvents, acids and alkalis; hydraulic presses, shears and power systems; and molding, forming and extrusion operations.

(This item supplements Ajax Iron Works data on pages 160-161 of the Composite Catalog, 20th Edition.)

For more data circle **No. E10** on Readers' Service Card, last page this issue.

Tank Switching Systems

A new system providing for automatic performance of lease operations includes controls, valves and instruments which perform all basic functions of filling storage tanks and opening and closing in wells in accordance with production requirements, storage capacity and pipe line runs. Basically, the system is pneumatically controlled; however, it can be supplied with electrical pilot controls when electrical operation is desired. Well shut-in controls can be pressure-actuated, electrically controlled or time-cycle controlled as desired. The entire pneumatic system is non-bleed, and the small volume of supply gas required can be supplied by the separator in nearly every instance.

These automatic tank switching systems operate in conjunction with any type of automatic gaging, testing or metering vessel, which equipment can be supplied with the systems when so specified. By eliminating the necessity for constant attendance at the batteries when tanks are being filled, the systems free lease workers for other, more important duties; they eliminate the hazards of climbing to tank roofs in order to gage tanks, and guard against tank overflow and the dangers of flow line breakage.

(This item supplements Garrett Oil Tools, Inc., data on pages 1777-1780 of the Composite Catalog, 20th Edition.)

For more data circle **No. E11** on Readers' Service Card, last page this issue.

Plug Injector

Installed on the flow line at the wellhead, the paraffin control plug injector permits insertion of paraffin control plugs without interrupting normal flow so as to avoid shut-down or use of auxiliary bypass line. The plug running operation can be performed in less than 30 seconds.

To operate—handlebar plug, incorporating speed thread, is unscrewed allowing gas trapped in upper chamber to escape through early opening vent. A swing check valve, normally held closed by spring tension, seals off plug receiving chamber from flow line. Paraffin control plug is dropped into upper chamber. Screwing on handlebar plug seals vent and forces paraffin control plug against swing check valve providing initial opening to balance pressures in plug chamber and flow line Manually shoving push rod down moves plug past check valve into flow line making the plug running operation positive regardless of flow rate.

Other features include elimination of oil spillage as there is no fluid to drain. Gas trapped in upper chamber maintains fluid level below check valve under normal low pressure flow line service.

The injection operation is performed with line pressure under 100 pounds per square inch, although the unit itself is rated much higher having been subjected to pressure tests exceeding 5000 psi, according to the manufacturer, Well Controls, Inc.

For more data circle **No. E12** on Readers' Service Card, last page this issue.

New Equipment Literature

Hose Maintenance Check List

Thermoid Company has recently released a new 11-point check list to help plant maintenance engineers and other users of industrial rubber hose obtain longer hose life and better performance. The four most common abuses of hose are illustrated.

The chart, printed on stiff cardboard, is designed for wall mounting in plant areas where hose is used. It is lacquered for protection against moisture, oil, grease and dirt.

To get a copy, circle **No. E13** on Readers' Service Card, last page this issue.

Well Logging Instruments

Price list and description of the well logging instruments made by Well Instrument Developing Company are included in a bulletin just released by the company.

For each of the Widco loggers, the illustrated booklet lists all specifications, their application and their potential.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Equipment Brochure

Dowell Incorporated has released a new bulletin on the use of Dowell equipment for oil field service. Specifications and uses of some of the latest Dowell units with illustrations of the equipment are given.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Diesel Engines

"Power for Progress" is the title of a new brochure by Detroit Diesel Engine division on the operation of General Motors "6-110" Diesel engines. Industrial and marine models in the series from 200 to 575 horsepower are also illustrated.

The bulletin covers features of design, specifications and power curves of single-, multiple-engine and torque converter units. Photos of these engines at work in various types of equipment are included.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Level Control

Equipment designed to provide a link between the capacitive-type electronic level-sensing equipment and the corresponding actuation of pneumatic control valves or other instrumentation is described in a new leaflet of Thermo Instruments Company.

This new Belmont level control utilizes an inert capacitive-type sensing probe suspended in the material to be controlled, and electronic control circuits which operate a pneumatic pilot valve. The literature shows in schematic form how the resulting pressure changes can either be used directly to operate a diaphragm control valve or can be fed into auxiliary automatic or manual control equipment where the pneumatic valve requires greater air volumes.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Protective Clothing

Heat reflecting aluminum and fire resistant asbestos are combined to give extra protection against high temperatures and flames in a new line of aluminized asbestos clothing announced by Industrial Safety Specialties Company. These special protective garments—designed for industrial workers, truckers, firemen, and rescue workers—are described and illustrated in a new folder just published by the company. As a novel feature, swatches of aluminized asbestos have been tipped on to the front cover.

Among the items offered in this new ISSCO folder are hoods, gloves, and coveralls for the industrial worker; a new type turnout coat, hood, and rescue suit for fire department use; and a rescue kit for truckers, police cars, and ambulances. The rescue kit contains fire blanket, hood, and gloves—for smothering tire fires, rescuing trapped victims and other emergency operations.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Engine Catalog

Eighteen heavy-duty power units are described in a new catalog just published by the International Harvester Company. The booklet lists six heavy-duty diesel power units, seven six-cylinder heavy-duty carbureted units and five four-cylinder carbureted engines with various attachments. Full specifications for application of the units to new installations or as replacements are also included in the catalog.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Oil Tool Publication

The Weatherford Oil Tool Company, Inc., has announced a new illustrated catalog describing the Weatherford line. Complete with engineering data, the book contains detailed instructions for installing the products and emphasis is placed on the Weatherford technique of well protection from channeling by use of various types of centralizers and scratchers. Several pages are devoted to recommendations for proper procedure of a cement job.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

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